PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

VOL. XX. CHICAGO, MAY 1, 1916 No. 9

Making Power for Palmolive Products

RECENTLY ENLARGED FACTORY OF B. J. JOHNSON SOAP CO. HAS POWER PLANT CONTAINING MODERN COAL AND ASH HANDLING SYSTEMS AND POPPET VALVE ENGINE; REFRIGERATING EQUIPMENT EMPLOYED FOR UNIQUE PURPOSE

REVIEWING THE PROGRESS made in the industrial arts and sciences within the last half century, we find many household commodities formerly made in the home now being produced in large factories built and equipped for that particular purpose. The cause of this, economists tell us, may to a large extent be traced to the development and perfection of labor saving machinery, modern manufacturing methods, the introduction of large-scale production and the division of labor. Among such various commodities which today may be more readily purchased, is soap.

Many of the present generation, and especially those who have spent their early years on the farm or in the smaller towns, will recall, and undoubtedly with many fond memories, the large, iron kettle possessed by almost every family, in which the family's soap supply was regularly prepared. It was customary in those days to save all fats and greases remaining from the kitchen, and when a sufficient quantity had been accumulated, to get out the old iron kettle, and place it above

FIG. 1. GENERAL VIEW OF THE ENGINE ROOM

a roaring fire somewhere in the back yard and boil these ingredients with a proper quantity of lye. The fire was then allowed to die down, and the mixture permitted to cool and solidify, after which it was cut up into cakes of convenient size and stored for future use.

Slowly, however, as soap manufactories became established, the housewife began to realize that she could obtain her soap at a lower cost and without the inconvenience and bother attending the making of the home-made product. This in turn hastened to increase the magnitude of the soap industry and, as a result, large plants were erected which devoted their entire efforts to the manufacture of this indispensable article.

One of the pioneers in this industry in the central states is the B. J. Johnson Soap Co., of Milwaukee, Wis., manufacturers of the universally known Galvanic Soap and the Palmolive products. The original plant of this company being totally destroyed in the historic Third-Ward fire of the early nineties, a new 6-story brick

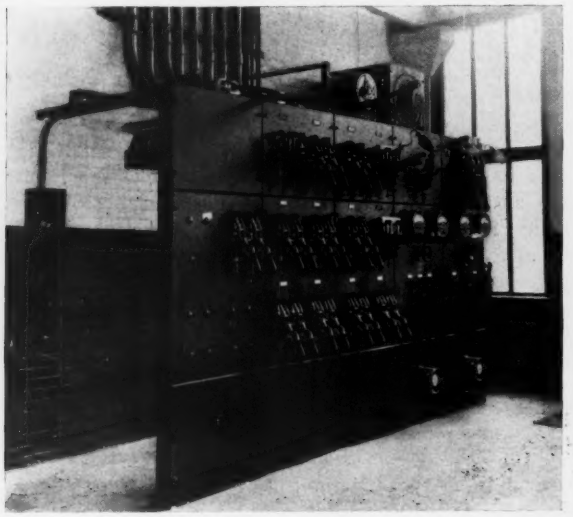


FIG. 2. IN CONFORMITY WITH MODERN PRACTICE NO KNIFE SWITCHES ARE EMPLOYED ON THE FEEDER PANELS

structure was immediately thereafter erected at the northeast corner of Fourth and Fowler Sts. This the company has occupied ever since. Due, however, to a gradual increase of business and the pressing need for larger and more modern quarters the Johnson company found it necessary to increase the size of its plant and, as a result, the past year has seen the construction of a modern steel, brick and concrete structure. This addition not only contains the latest machinery used in the soap industry, but is provided with every facility conducive to the convenience, comfort and welfare of the employe, such as modern toilet rooms equipped with shower baths, rest room, lunch rooms, and sterilized and artificially cooled drinking water. The lunch rooms and general offices, which are located on the sixth floor, are provided with a continuous supply of air, thoroughly washed, heated in winter and cooled in summer, by a Sirocco System of Purifying, Cooling and Humidifying, manufactured by the American Blower Co.

Essentially, this purifier consists of a galvanized-iron casing housing a set of cast-iron tempering coils, a purifying chamber containing spray heads, galvanized-iron wet scrubbing plates, which serve as a scrubbing surface for removing small particles of bacteria-laden air and other foreign matter, and eliminating plates provided as auxiliaries to take care of any moisture that may have passed through the first battery. Directly attached to the outlet of the purifier casing is the suction of an engine-driven blower which delivers air to the ducts leading to the lunch rooms and offices.

A small motor-driven centrifugal pump takes the water from the settling tank located at the bottom of the purifying chamber and delivers it to the spray heads, which are made of brass and of such construction as to permit of regulating the pressure and density of the spray. For flushing purposes, each head is equipped with a diaphragm connected by small copper tubes to a system of galvanized-iron flushing pipes. By opening a 3-way cock in the main supply pipe to this flushing

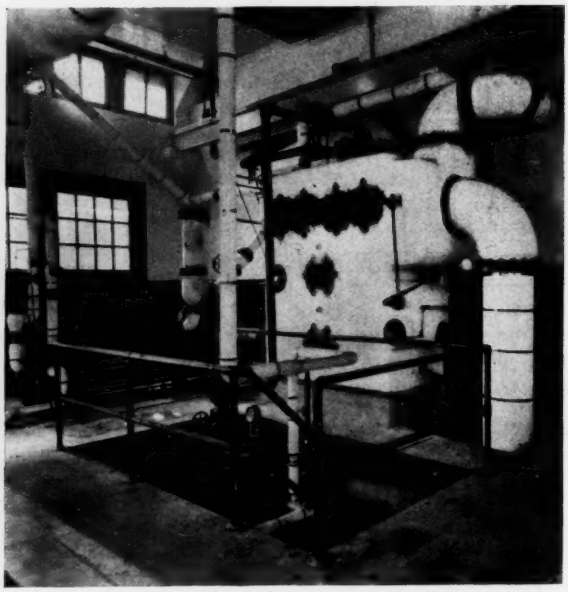


FIG. 3. THE VACUUM PUMP IS INSTALLED IN A PIT DIRECTLY IN FRONT OF THE HEATER; IN THE BACKGROUND ARE THE BOILER-FEED PUMPS

system, water under pressure is admitted to the diaphragms, opening all heads instantaneously and allowing water from the pump to flush out any dirt or sediment that may have lodged in the heads. The heads give a finely divided radial spray under comparatively low pressure, discharging the water in the direction of the air current and thereby assisting the flow of air through the scrubbing and eliminating surfaces.

This equipment being under control of a Johnson System of Heat Regulation is entirely automatic throughout and except for occasional cleaning, requires but little attention.

The Power Plant

Many years of experience in the manufacturing business having already convinced the management of the economy and reliability of an isolated plant for this kind of an industry, provision was made for a modern steam and electric generating equipment. The old plant,

the greater part of which is now out of use, excepting the boilers and their auxiliaries, and a 25-ton Vilter refrigerating machine, consisted of 4 72-in. by 18-ft. return-tubular boilers equipped with Jones Underfeed Stokers, an 18 by 36-in. Vilter Corliss engine belted to a 150-kw. Crocker-Wheeler direct-current generator, the refrigerating machine referred to above and the necessary boiler-feed, elevator and vacuum pumps.

The boiler room, an independent steel and concrete building separated from the engine room by an 18-ft. driveway, contains in addition to the 4 old steam-generating units, 2 Erie City horizontal water-tube boilers, each rated at 300 hp., and equipped with Murphy Automatic Smokeless Furnaces and Stokers. When operating at full load, a pressure of 175 lb. gage is carried. A 175-ft. reinforced concrete chimney, having an internal diameter of 7 ft. 6 in. at the base and located directly outside of the building, is connected to the 6 boilers by sheet-metal breeching.

Water for steam generating purposes is obtained from the local water mains and, after passing through the heater, is delivered to the boilers by either one of 2 feed pumps, one of which is a 12 by 7 by 12 in. Warren simplex unit and the other a Dean Bros. duplex having dimensions of 8 by 5 by 12 in.

For emergency service a 2-in. Metropolitan injector has been installed.

The blowoffs from the various boilers, each of which is blown down once every 12 hr., connect to a common header which discharges into a cast-iron blowoff tank 4 ft. high and 3 ft. 6 in. in diameter. From this tank the water and sludge pass into the city sewers.

Handling Coal and Ash

Youghiogheny screenings is the fuel used. This is delivered to the plant in wagons and trucks and dumped into a receiving pocket outside of the boiler room. Here it is picked up by the buckets of a Chain Belt bucket conveyor having a capacity of 20 tons per hour and discharged into a screw conveyor which distributes along the bunkers above. These bunkers, which are supported by the steel framework of the building, are of reinforced concrete and have a maximum capacity of 100 tons. Steel chutes provided with sliding gate valves operated from the floor below by means of chains, deliver the coal into the stoker hoppers.

Ashes are removed from pits in front of the boilers by means of a Green steam-jet conveyor which raises them 40 ft. into a steel plate bin having a capacity of approximately 250 cu. ft. A chute leading from this bin provides a ready means for their removal into wagons for final disposal.

In the Engine Room

Reference to Fig. 5 will give the reader a general idea of the layout of the engine room, which, being integral with the main factory building, is likewise of concrete and steel. The ceiling and walls are painted white, with a green trim, and the floor a light gray, which, together with the color scheme of piping employed, gives the interior a pleasing and inviting appearance.

Large windows on 3 sides of the room provide excellent illumination during the hours of daylight, while 8 uniformly distributed lighting units, each consisting of a 400-w. nitrogen-filled lamp, opalescent globe and white-enameled reflector, furnish the necessary artificial lighting.

Due to the general construction of the building, calling for the placing of 2 large supporting columns along the center-line of the engine room, it was impossible to install a crane of the desired span. To overcome this detrimental feature, 2 cranes, the tracks of which are mounted between these columns and the walls are used instead. These cranes are hand operated and have a capacity of 10,000 lb. each.

The steam-driven electric generating equipment consists of 1 20 by 32-in., 500-hp. Nordberg High-Efficiency poppet-valve steam engine, operating at a speed of 150 r.p.m. and direct connected to a 375-kw., 120-v. Allis-Chalmers direct-current generator, and 1 12 by 12-in. Ball high-speed engine, running at 275 r.p.m. and direct connected to a 50-kw., 120-v. Sprague direct-current generator. The poppet-valve engine referred to above

FIG. 4. THIS DUPLEX TANDEM COMPOUND IS USED FOR THE OPERATION OF THE 3 HYDRAULIC ELEVATORS

is similar in construction to those installed in the Lumber Exchange Building, Chicago, a detailed description of which may be found on page 524 of the June 1, 1915, issue of this paper.

In the northwest corner of the engine room, as shown in Fig. 2, is the switchboard. This is made up of 5 black slate panels, 2 of which are for the control of the generators, while the other 3 carry the distribution switches, which in this case consists solely of 2 single-pole circuit breakers for each circuit, no knife switches being employed. The voltmeters and ammeters are of the Weston make, while Sangamo integrating watthour meters installed on each generator panel record the output of each machine.

Distributing leads from the switchboard are carried to the various floors and departments in iron conduit, all of which is painted green to distinguish it from piping. At the present time, 13 circuits with a total connected load of approximately 430 hp. are installed.

In addition to the generating units and switchboard, the engine room also houses the 2 boiler feed pumps, an 8 by 10 by 12-in. Warren simplex vacuum pump used in connection with the heating system, and a 10 by 16 by 8½ by 18-in. Warren tandem-compound duplex pump for the operation of 3 hydraulic elevators, 2 of which are for freight and have a capacity of 5000 lb. each,

while the third, capable of carrying a load of 3000 lb., is for passenger service only. All of the above pumps are equipped with Fisher Automatic Pump Governors.

Boiler makeup water and that returned from the heating system and drips is delivered to a 1600-hp. Cochrane feed water heater also located in the engine room.

Exhaust steam from the 2 generating units, refrigerating machine and all pumps is delivered to the heater through a 16-in. inlet, and that not required to heat the feed water is used in the heating system, the soap

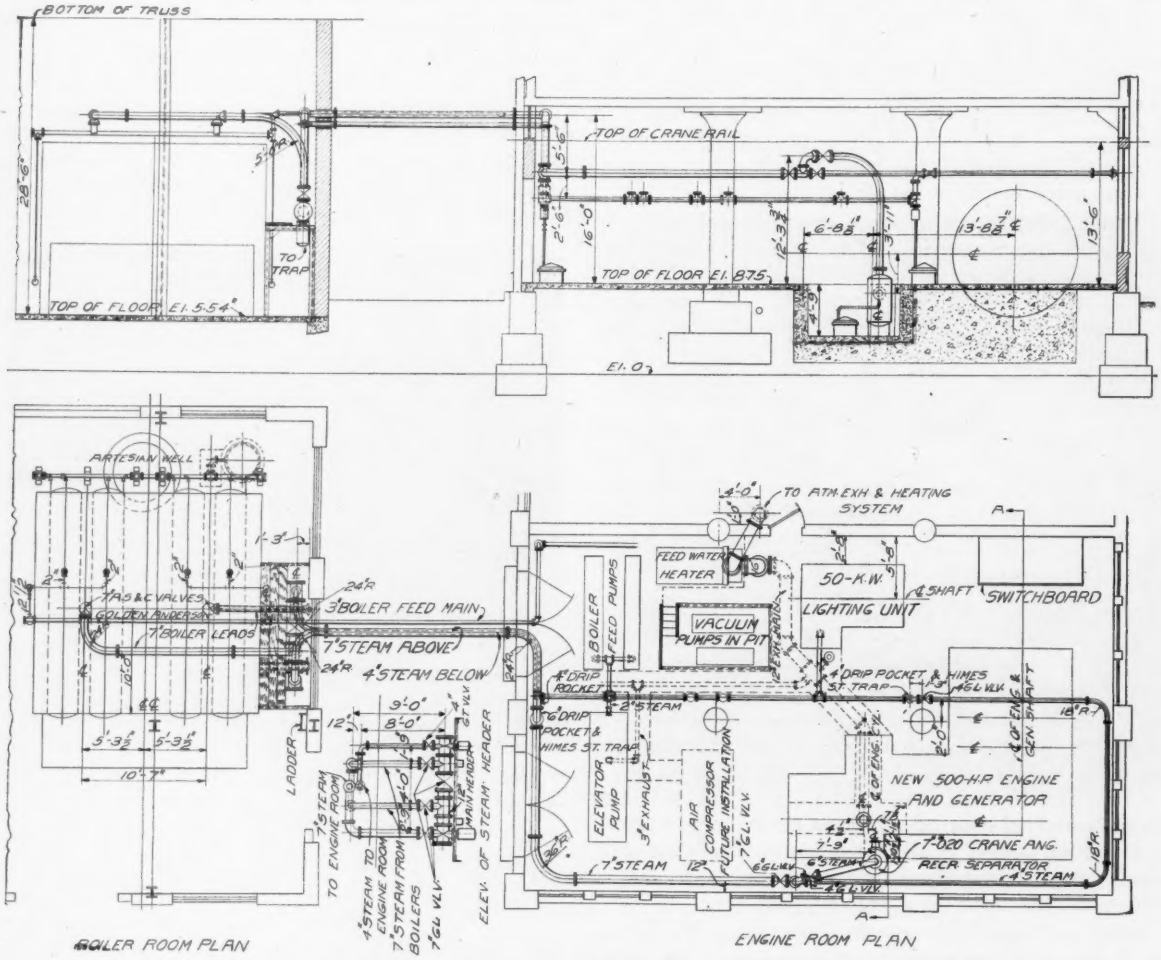


FIG. 5. PLAN AND ELEVATION OF NEW POWER PLANT OF B. J. JOHNSON SOAP CO.

driers and the glycerine room. All of the excess is allowed to escape to the atmosphere through a 12-in. relief valve.

The pressure carried in the heating system varies from 2 to 2½ lb. gage reduced from the high pressure by a 3 by 6-in. Fisher reducing valve.

Piping System

As will be noted from Fig. 5, the entire steam supply for the power plant is obtained from the 2 300-hp. boilers, the older return-tubular units supplying steam for manufacturing purposes only. Many of the processes employed depend upon the continuous operation of the respective machines and to reduce the liability of power failure to a minimum, special precautions have been taken in the design of the piping connecting the boilers and prime movers. The 2 boilers supplying steam to the engines, are connected to a 12-in. header by 7-in. lines equipped with Golden-Anderson Stop and Check Valves. From the header, which is supported by brackets on the north wall parallel to the center lines of the boilers, 2 lines, one 7-in. and the other 4-in., are carried across the 18-ft. driveway and into the engine room, where the former feeds the Nordberg-Allis-Chalmers unit and the latter the pumps and the Ball-Sprague unit, and is carried around in the form of a loop until it joins the 7-in. line at the Nordberg engine. Should, therefore, any section of the line between the boiler room header and any point in the engine room become disabled, it may readily be cut out and the supply of steam but little impaired. All of this piping is equipped with fittings of the Crane high-pressure type, and is covered with Johns-Manville 85 per cent Magnesia covering. The sections of 4 and 7-in. steam lines and a 3-in. boiler-feed line between the engine and boiler rooms being exposed to the weather, are in addition to the Magnesia covering protected by a layer of wool felt around which is wrapped a patented waterproof covering.

Himes Steam Traps are used throughout the power plant and factory for the removal of condensation, which is returned to the heater for re-use.

A 9-in. exhaust pipe coming from the poppet-valve engine is joined at a 9 by 12-in. cross by a 5-in. line from the Ball high-speed engine and a 6-in. line from the pumps. From here a 12-in. line conducts the exhaust to the heater riser, at which point it is increased to 16 in. The heater outlet connecting with the heating lines and atmospheric exhaust is 12 in. in diameter. All exhaust piping, which is carried in a concrete trench up to the heater, is protected by the same grade of covering as are the high-pressure lines.

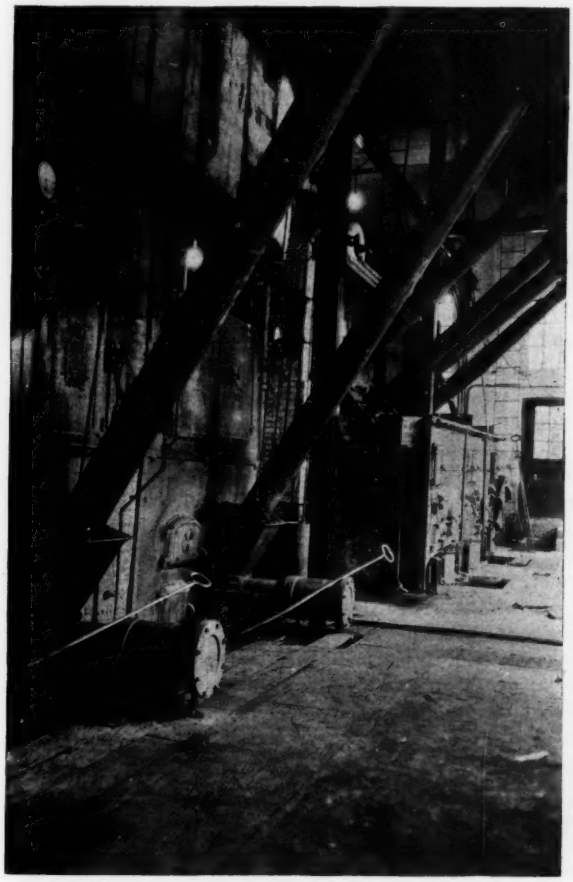


FIG. 6. AUTOMATIC COAL AND ASH HANDLING MACHINERY TENDS TOWARD EFFICIENCY AND ECONOMY AND A CLEAN AND ORDERLY BOILER ROOM

A color scheme whereby the operators are enabled to distinguish the various pipes lines is employed. For high and low-pressure steam the color is white; for water, blue; for brine, black; for the sprinkler system, red; and all electric conduit, green.

Refrigeration Load

In the old engine room may still be seen running the little 25-ton Corliss-engine-driven Vilter refrigerating machine. Its duties are out of the ordinary and it may be of interest to the readers to hear of the use to which this machine has been put.

In the manufacture of Johnson's Washing Powder, the ingredients are placed in a large kettle in which they are mixed and boiled. Due, however, to its being in a liquid state and at an exceedingly high temperature, it is necessary that this mixture be cooled before being pulverized and packed. Natural cooling would, especially during the summer months, require many hours' time and in order to hasten the process and thereby reduce the cost of production, the hot mixture is allowed to flow from the mixing tank through a pipe to the floor below, where it is directed between 2 hollow cast-iron rollers. These rollers are connected to the brine lines and are maintained at a comparatively low temperature so that, as the hot mixture flows between them, it is at once chilled and by means of scrapers removed in the form of powder. The use of these cooled rollers so greatly hastens the process of manufacture, that instead of requiring many hours of time, the powder is being packed in boxes in less than 5 min. after leaving the kettle above.

Sprinkler System

In spite of the fact that this factory is of fireproof construction throughout, the entire building is equipped with a modern sprinkler system, thus reducing the danger of fire to a minimum. Water for this system is obtained from the city water mains at a pressure of 60 lb. per sq. in., and is stored in 2 wooden tanks located on the roof and having a capacity of 35,000 gal. each.

The entire system, made by the General Fire Extinguisher Co., is of the wet type, excepting those sections in the garage, warehouse and driveways. These, due to their exposed location, are of necessity dry.

This plant, which at the present time is in charge of Geo. Beierly, Chief Engineer for the B. J. Johnson Soap Co., was designed by Lockwood, Greene & Co., Engineers, of Chicago.

Improving Boiler and Furnace Efficiency

Important Furnace Details and Dimensions; Influence of Economizer on Efficiency. By Victor J. Azbe

BOILER and furnace economy ordinarily is not what it ought to be, and the combined efficiency often is no higher than 50 per cent. By having clean heating surface and paying closer attention to the process of combustion this efficiency is increased but seldom reaches a point higher than 60-65 per cent. Even after this point is attained and apparently conditions are as they ought to be, there are still ways further to improve economy and also the capacity of the boiler plant.

With chain grate stokers trouble is often realized due to fires burning away from the feed gate. This causes CO_2 to drop due to the air flowing into the furnace through nonignited fuel upon the grate, and at the same time reducing the capacity due to the reduction of effective grate surface. The trouble is due to the ignition arches being set too near the grate, or not at the proper angle. Ordinarily the ignition arch is built 11 in. over the grate in front, and about 18 to 22 in. in the rear, while it should be 16 in. in front and 24 in.

in the rear. By raising the ignition arch a bright flame will be established immediately after the coal emerges from underneath the coal gate, while otherwise the coal is heated to the ignition temperature at a considerable distance from the feed gate, and then the flame is of a dull red color.

When the ignition arch is raised, care should be taken that the side walls are built out in such a way that it protects the side frames of the stoker, otherwise there is danger of burning them. With some makes of chain grate stokers, it will be necessary to get longer gate tile to prevent burning of feed gate frame. If the foregoing precautions are taken, success and satisfaction will result from the change, as they have in many plants.

Excess air is the cause of considerable loss in burning the fuel and while its reduction is a saving of heat and consequently fuel, this is true only down to the point when the loss due to incomplete combustion will offset the saving. Excess air is required for complete combustion because with the theoretical amount only, some of the combustible molecules will be unable to come in contact and combine with the necessary oxygen, and due to this escape unburned.

Combustion chambers should be roomy and grates should be 7 ft. below the heating surface of the boilers, thus giving sufficient time to the combustible molecules for the search of the oxygen. The larger the combustion space and the more time given to the gases for mixing, the less excess air will be required for the complete combustion.

The furnace should be large, and the bridge wall should come as close under the boiler as possible without unduly checking the draft; this restricted space will have the effect of drawing the gases together and mixing them. The combustion space in the rear of the bridge wall again should be as large as possible.

Installation of mixing baffles behind the bridge wall is also of considerable value, especially with hand-fired boilers, when smoke prevention is necessary.

In all cases when there are distances of 5 ft. or more between the grate and the heating surface, this heating surface should be exposed to direct heat from the fuel bed. At this point, the heating surface is most active and any obstruction to the direct radiation of heat from the fuel-bed will cause higher flue-gas temperatures and consequently fuel loss. A saving of as much as 5 per cent was obtained by having T tiles instead of C tiles upon the lower row of horizontally baffled water-tube boilers.

In all cases when more draft is obtainable than necessary, this can be taken advantage of by lengthening of the baffles; this will help improve economic conditions, as it will cause the gases to take a longer travel, thus reduce the amount of dead space and prevent short-circuiting of the heating surface. When this is done, care should be taken that not too much of the opening is closed off; otherwise the resistance to the passage of gas will be too great, and will reduce the maximum capacity of the boiler too much.

In Germany and in England economizers are in general use while in this country only comparatively few plants are equipped with them. The main reason for this is their initial cost, reduction of available draft, and the comparative low cost of fuel. The objection from the financial standpoint is wrong, as the investment will bring from 10 to 30 per cent returns yearly. As to the second, it is true that quite a large proportion of power plants will be unable to use economizers without installing a mechanical draft system, but there are also many that could use them and still have sufficient draft to burn the required amount of coal, because efficiency will be greater and not so much coal will have to be burned to generate the required amount of steam. The third holds good in some parts of our country where a large amount of coal is mined, but there are places where coal is very expensive and economizers could be installed and bring good returns upon investment.

A reduction of flue gas temperature could be obtained by passing the gas from one boiler to another, one acting as economizer; in this way, idle boilers could be made use of, with a consequent rise in efficiency. When this is done, care should be taken that the temperature of gas going through the economizing boiler is not reduced below 400 deg., as low temperature flue gas is a very strong corrosive agent due to presence of sulphur dioxide and consequent formation of sulphurous and sulphuric acids at low temperatures. The danger from corroding the tubes generally prevents us from using idle boilers as economizers; but in plants where flue gas temperatures are high, good results can be obtained without going too low.

Economizers are of greatest value when feed water is cold, but 212-deg. water is no reason why they should not be used, as they would be able to heat the feed water to 300 deg. or more; the proper thing, however, would be to connect the exhaust of all steam driven machinery to the condenser and thus reduce their steam consumption and use the economizers only, for heating the feed water.

In plants where economizers are employed, it is necessary if full benefit is to be obtained, that the flue gas reaches them at as near the temperature it leaves the boiler as possible. Leaky dampers on dead boilers, leaky breechings, and leaky cleanout doors will greatly reduce the value of economizers. It would be well in such plants to connect the flue gas analysis instrument at the end of the economizer, sample the gases and compare the percentages of CO_2 obtained with the CO_2 obtained from the boiler uptakes, this information giving an idea of the amount of air inleakage.

FOR THE LAST YEAR, the demountable rim has been practically the only one used in the better grade of automobile construction. This had a great advantage over the old style of detachable rims, because of the convenience of change.

The new type of quick detachable rim made by the Goodyear Tire & Rubber Co., of Akron, O., has been simplified and made convenient so that the weight is reduced and a change of tires can be made in less than a minute, leaving only the inflation to be taken care of. With modern quick-acting pumps this is a short process, and the lighter weight of wheel rims, the avoidance of the weight of the extra rim, or 2 rims for long touring work, on the car, and particularly the availability of this method for wire wheels gives indication that the detachable rim will again come into common use.

Automatic Valves

BOILER LAWS REQUIRE USE OF NON-RETURN VALVES, BUT GENERALLY FAIL TO SPECIFY PROPER TYPE AND LOCATION. BY J. C. HAWKINS.

MANY of the states and municipalities that have enacted boiler laws have incorporated a clause similar to the following: "Where 2 or more boilers carrying over 100 lb. of steam pressure are connected to a common header, there shall be 2 stop valves on the branch to each boiler, one of which shall be a non-return valve." While this is an excellent provision, it is just as necessary that these laws should take into account the type of valve and its proper location. The idea of equipping a boiler with non-return valves is to lessen the danger of employes being scalded, in case of tube failure or other accident, to prevent putting the rest of the plant out of service by closing the connections to the boiler at which the trouble occurs, and to make it impossible to turn live steam from the header into a cold boiler when it is standing idle or possibly undergoing repairs or cleaning.

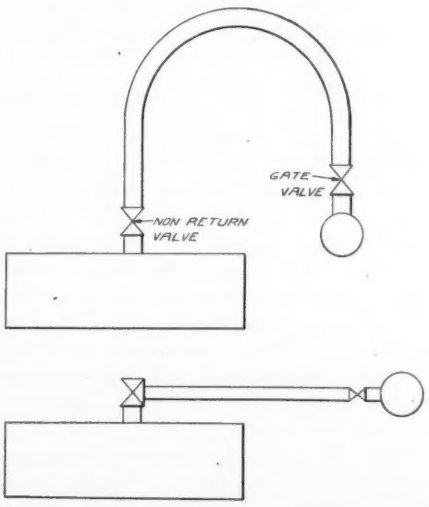


FIG. 1. WITH THIS FORM OF CONNECTION, ANY WATER COLLECTING BETWEEN THE 2 VALVES CANNOT BE READILY DRAINED WITHOUT USE OF DRIP PIPES

While these laws make it necessary to install such protective devices, they stop there, or in some cases may perhaps further state that one valve shall be next to the boiler and the other at the header, regardless of the shape or position of the connecting pipe. They make no provision whatever for the elimination of waterhammer. Non-return valves will not open until the pressure is equal on the 2 sides and any water that collects above the seat must be removed by drip pipes of proper construction. If the non-return valve is placed next to the boiler, as shown in Fig. 1, with the gate valve at the header end, any water collecting between the 2 valves cannot be drained until the pressure is equalized on both sides of the valve, unless drip pipes are used, which the law does not require, and which must be operated by hand. For this reason, the 2 valves should be placed at the highest point of the steam line, whether at the boiler end, at the header end, or in between, and should be bolted together to prevent the formation of any water pocket between them. Figure 2 illustrates this idea.

Where the ordinary single-disc type of non-return valve is used, the job is only half completed. While it is true that the steam from the header and other boilers

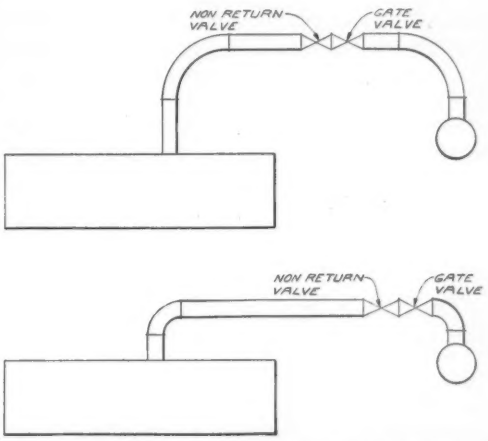


FIG. 2. PROPER LOCATION AND METHOD OF CONNECTING GATE AND NON-RETURN VALVES

will be cut off in case of a tube failure, there is nothing to prevent the water and steam from being drawn out of the boiler, in case a large tee, for instance, on the header gives away. This would not cause the valve to operate, would shut down the entire plant and be likely to burn the boiler or tubes if a heavy fire was

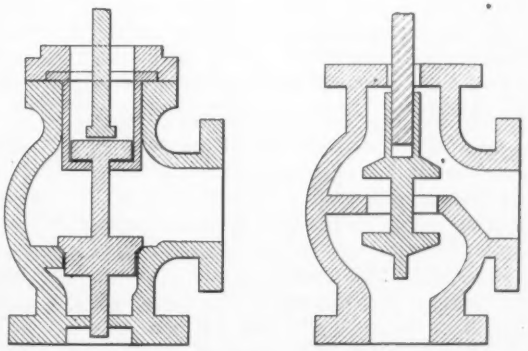


FIG. 3. VALVE AT RIGHT DESIGNED TO OPERATE EITHER WAY; VALVE AT LEFT, SINGLE ACTING ONLY

at the time being carried. Boiler trouble is more probable than header trouble, but the latter should be guarded against. If a valve is properly designed so that it can close either way, as shown at the right of Fig. 3, the boiler can be cut out in case of accident and the safety valves allowed to care for the increasing steam pressure.

The gate valve on each header may then be closed, although the automatic valve could not open until the header pressure again equaled the boiler pressure. Equipping boilers with non-return valves may satisfy the requirements of the law, but it does not protect the rest of the plant; the laws should apply to the steam main as well as to the boiler. Frequently accidents occur, either to some part of the steam line or to the engine, possibly causing loss of life and property, and which, with the proper arrangement of valves in the steam line, could have been localized and the damage reduced to a minimum or avoided entirely. In many plants head room above boilers and steam line is so low that in case of a large break in the line, it is practically impossible to reach any important valve to close it by hand. Even if the main valve is accessible, if of any size it will have a long thread and usually turn hard, rendering it impossible to stay with it long enough to close it.

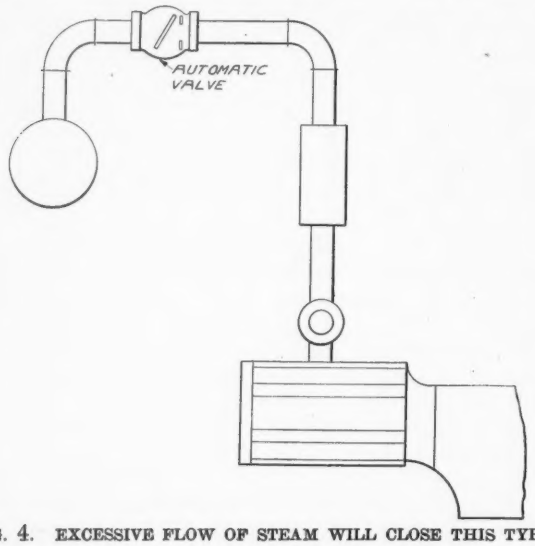


FIG. 4. EXCESSIVE FLOW OF STEAM WILL CLOSE THIS TYPE OF VALVE AND PREVENT SERIOUS ACCIDENTS

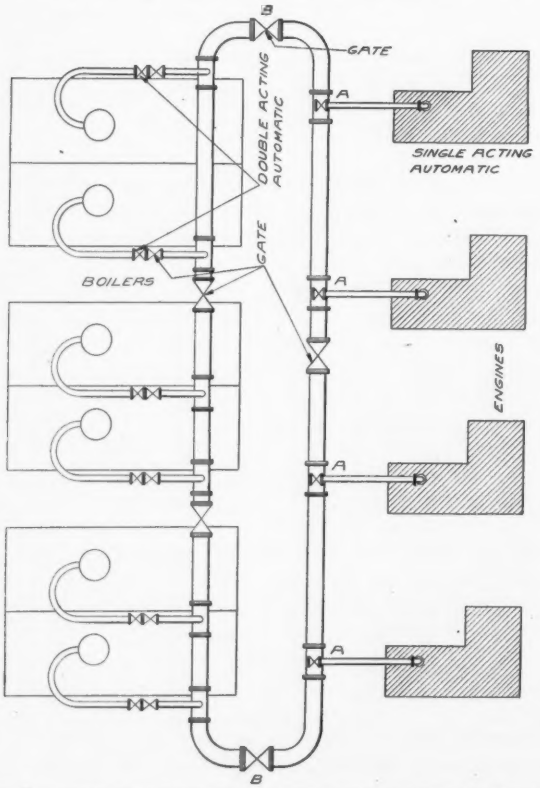


FIG. 5. PROPER LOCATION OF AUTOMATIC VALVES ON STEAM SYSTEM OF THE LOOP TYPE

Automatic engine stops applied to the engine and by means of which the throttle valve is closed, should the engine overspeed from any cause, will stop the engine before any damage is done. If, however, an accident to the engine is caused by water, broken follower studs which may knock out the cylinder head, or other cause which does not affect the engine speed, the safety stops may not operate, and cause accidents resulting in loss of life through scalding from escaping steam. To prevent accidents of this kind, automatic valves should be placed on the branch to each engine, as shown in Fig. 4.

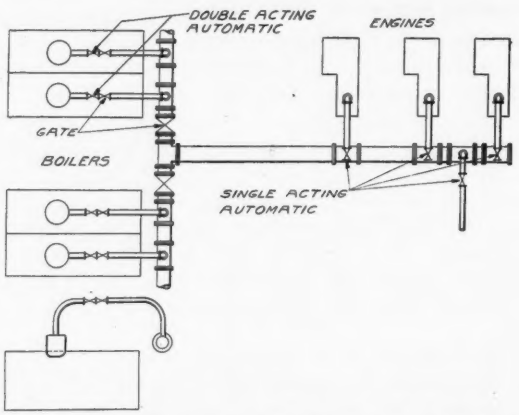


FIG. 6. PROPER LOCATION OF AUTOMATIC VALVES ON STEAM SYSTEM NOT OF THE LOOP TYPE

This valve could replace the gate valve usually placed at the header end of the branch. With the automatic valve located at this point, a sudden draft of steam would close this valve and cut out that particular part of the line without affecting the rest of the plant. It would, of course, have to be counterbalanced to prevent it from closing with a change of engine load.

Where the automatic engine stop is employed, it could be made to operate on this valve as well as on the throttle valve.

When the steam system is arranged in a loop with several engines and boilers, as shown in Fig. 5, double-acting automatic valves should be placed on the boiler branches with the automatic and gate valves bolted together rather than one on either end, and should be placed at the highest point of the branch to eliminate the possible formation of water pockets. An automatic cutoff valve which needs to open or close in only one direction, should be placed at the header on each engine branch, as shown at A. The legs of the loop should be divided with gate valves, as shown at B. All valves over 6 in., either automatic or gate, should be provided with a bypass for warming up the line and draining any

water that may collect above the valve when it is closed, as it is not always possible to prevent this in the engine branches. Figure 6 shows another type of steam system and the manner in which the valves should be located. It would cost but little more to use the proper type of valves and locate them as they should be than to use the plain gate valves which are used simply because it is the custom.

If engineers are going to aid in furthering the "safety first" movement, there is no better place about the plant, where the elimination of accidents will be of more benefit than in safeguarding life and property against escaping steam by properly constructing and valving the steam line. In order to do this, however, it may be necessary to develop a new type of valve that will give the proper action.

Turbines vs. Engines in Units of Small Capacities*

CONSIDERATION OF POWER CAPACITY OF APPARATUS, EXHAUST AND SPACE. BY J. S. BARSTOW.

LOWER cost of large turbine units and the greater reliability of this kind of apparatus in regular service, coupled with the smaller space taken up by turbines as compared with engines, has practically put the engine out of the running as far as large power plants are concerned. Where 60-cycle apparatus is installed and condensing units are used, the engine has no field beyond the 500 kw. mark, while with direct connected 25-cycle apparatus, the engine must stop beyond the 1000 kw. limit, and with the perfection of high speed reduction gears, it is doubtful if 25-cycle engine driven generators can compete with turbine apparatus of even 500 kw. capacity. The reduction gear is also rapidly driving the engine from the direct current field in units of all sizes, above, say, 200 kw. capacity. At the same time, elimination of operating troubles by the use of direct connected turbines for exciter purposes is fast causing the turbine to supplant the engine for this service.

In the case of non-condensing units where moderate speeds are required, the engine must continue to hold the field, though special conditions may make the non-condensing turbine a factor to be considered. In this connection, one installation might be mentioned where a belted turbine of 750 hp. capacity, running at 1500 r.p.m., is used for driving the constant speed shafting of a paper mill, it being contended that the greater uniformity in rotative speed secured by the turbine results in fewer breaks and a more satisfactory product. In this case, the exhaust steam is, of course, utilized in the dryers of the machine, and the variable speed power is supplied by direct current motors.

RELATIVE SPACE REQUIREMENTS

OWING TO the freedom from reciprocating motion, the foundations required for turbines are of small size and light weight, there being little vibration to be absorbed when the alinement and balancing are well done. The small sizes can be safely operated on floors of usual construction, designed for the ordinary floor loads. There is no difficulty experienced with the transmission of vibration to the structural members of the building or to the piping system.

The small space required for the installation of a turbine gives it an advantage in water works plants, operating against moderately high heads. The vertical triple expansion engine, which was formerly used almost exclusively for such work, requires a strong massive substructure to absorb the shock and distribute the weight, and a deep pit to accommodate the water end. Where foundation or other construction difficulties are encountered in this work, the cost may easily climb to a high figure, and in a case under the author's personal observation the additional cost of building, incidental to the use of the vertical triple engine, would have more than paid for a turbine driven centrifugal pump, while the fixed charges on the pump alone were more than 4 times the cost of the fuel required to run it to full capacity 10 hr. a day.

The turbine driven pump is not capable of showing on test the high duty of the vertical triple engine—which is one of the most economical steam engines—but the great difference in the first cost of installation often makes the turbo set decidedly preferable, especially when the saving in building is considered. A geared turbine unit to pump 100 million gallons a day against a 56 ft. head was recently installed in Ross Station, Pittsburgh; the pump speed was 350 r.p.m. and that of the turbine 3600 r.p.m. On the duty trial, with steam at 151 lb. and vacuum 28.38 in., the pump showed a performance, including power consumed by the auxiliaries, of 120.5 million ft. lb. per 1000 lb. of dry steam, corresponding to 16.44 lb. of steam per whp.-hr. Six similar sets, ranging in capacity from 6½ to 30 million gallons a day capacity, are now in process of construction. The displacement of the reciprocating engine from a field where its superiority was formerly unquestioned, shows the substantial progress which has been made in the development of the steam turbine and the centrifugal pump.

For boiler feed pumps of more than 250 g. p. m. capacity, the turbine is often used, and on account of its small size, usually results in a neater and more compact layout. Where regulation by throttling is unnecessary, and the pumps run at or near capacity, the economy as compared with the direct acting type is good and can be better maintained. Valve renewal and packing troubles are avoided. The overload capacity of the centrifugal type, however, is small and the delivery of the pump must be proportioned to meet the maximum demand, not the average boiler horsepower requirements. In the smaller sizes, the cost of turbine units is high; where the load fluctuates widely and the speed must vary, the economy is poor and it is better to install reciprocating pumps.

In the modern plant containing large turbo-generator units, space limitations in the basement arrangements are an important consideration. With the high vacua carried, large volumes of water must be handled and the

*From a paper read before the A. S. M. E. and continued from page 249, Mar. 1 issue.

turbine drive for circulating, condensation and air removal pumps is in many cases the proper selection. Such condenser sets have a compact arrangement, especially when a single turbine is used to drive all the pumps, which greatly relieves the crowded condition that would otherwise obtain. As previously stated, they are also preferable as being more reliable.

The turbo-compressor supplying air to blast furnaces under pressures ranging from 20 lb. to 30 lb. has almost entirely supplanted the compound reciprocating blowing engine. One large concern formerly in this work has abandoned the construction of blowing engines and is now building turbine apparatus exclusively. For this service, the turbine may be run from 2500 to 4000 r.p.m., and there is a great saving of weight and space, as an engine of this type is 6 or 8 times as heavy as the centrifugal blower, and consequently costs much more. It can be installed comfortably where the blowing engine would be out of the question, and in new installations the relative cost of building and foundation for the 2 types has a direct and important bearing.

Utilization of Exhaust Steam

The advantage of an oil-free exhaust is in many plants of considerable value, and especially so in manufacturing processes where steam is used, as there are many such opportunities for the utilization of low pressure steam if the oil has been eliminated. For the blocking of hats and in the treatment of other felt and textile products, absolutely clean steam is necessary. As heretofore mentioned, paper manufacturers have used turbines for driving the constant speed mechanism of paper machines in order to secure more uniform angular velocity, and to avoid among other things trouble caused by oil accumulation in the drying rolls. The danger of oil deposits in high pressure steam boilers is well known to all.

In chemical processes where steam is used for precipitation, as in the precipitation of magnesia, a small fraction of a grain of oil per gallon will often retard the process or cause the precipitate to be of an entirely different character from that obtained with oil-free steam. The separation of the oil in exhaust steam is never absolutely complete, and fatty constituents are especially apt to pass the separator.

Available Cooling Water Supply

Where the available cooling water supply is limited and must be artificially cooled and recirculated, the cost of the cooling apparatus and the power required must be considered. The conditions will, perhaps, be best illustrated by an example: Assuming a turbine to run at 28 in. vacuum, and a temperature rise of the cooling water to within 10 deg. of that due to the vacuum, the circulation of 52 units by weight of cooling water for each unit of steam condensed will be necessary. In the case of the engine, which will operate at, say, 26 in. vacuum, other conditions remaining the same, there will be from 25 to 27 lb. of cooling water to be handled for each pound of steam condensed.

With a cooling pond returning water at 90 deg. to produce 27 in. vacuum in a turbine plant, the pumps must circulate 70 units of cooling water per lb. of steam, as against, say, 30 units required to produce 25 in. vacuum for the reciprocating engine.

Operating Advantages

From the operating point of view, the turbine possesses a great advantage in the simplicity of its construction, a factor which tends toward increased reliability and lower cost of maintenance. It can usually be more quickly started and loaded and, in operation, usually requires very much less attention than an engine unit of corresponding capacity. The lubricating arrangements are few in number and of simple design.

Summary

Summarizing the foregoing, the fields of usefulness of the turbine and engine may be briefly stated to be:

Applicability of Turbines

1. Direct connected units, operating condensing. 60-cycle generators in all sizes, also 25-cycle generators above 1000 kw. capacity. (This paper is, however, not intended to deal with units of this size.)

Direct current generators in sizes up to 1000 kw. capacity, including exciter units of all sizes.

Centrifugal pumping machinery operating under substantially constant head and quantity conditions, and at moderately high head, say from 100 ft. up. depending upon the size of the unit.

Fans and blowers for delivering air at pressures from 1½ in. water column to 30 lb. per sq. in.

2. Direct connected units, operating non-condensing for all the above purposes, in those cases wherein steam economy is not the prime factor or where the exhaust steam can be completely utilized, and, in the latter case, particularly where oil-free exhaust steam is desirable or essential.

3. Geared units, operating either condensing or non-condensing for all the above mentioned applications, and in addition, many others which would otherwise fall in the category of the steam engine, on account of the relatively slow speed of the apparatus to be driven.

Applicability of Engines

1. Non-condensing units, direct connected or belted and used for driving:

Electric generators of all classes excepting exciter sets of small capacity, unless belted from the main engine.

Centrifugal pumping machinery, operating under variable head and quality conditions and at relatively low heads, say up to 100 ft., depending on the capacity.

Pumps and compressors for delivering water or gases in relatively small quantities and at relatively high pressures—in the case of pumps at pressures above 100 lb. per sq. in. and in the case of compressors at pressures from 1 lb. per sq. in. and above.

Fans and blowers (including induced draft fans) for handling air in variable quantities and at relatively low pressures, say not over 5 in. water column.

Line shafts of mills, where the driven apparatus is closely grouped and the load factor is good.

All apparatus requiring reversal in direction of rotation, as in hoisting engines and engines for traction purposes.

2. Condensing units direct connected or belted, for all the above purposes, particularly where the condensing water supply is limited, and where the water must be re-cooled and re-circulated.

When Locomotives Fall by the Wayside

INTERESTING EXPERIENCES WITH NARROW GAGE LOCOMOTIVES. BY H. K. SCHOLEFELD

IN a sugar plantation, cane is hauled from the fields to the factory over a narrow gage railroad, by locomotives varying from 12 to 20 tons in weight. The trains are seldom driven faster than 10 mi. an hour, and where portable track is used, not more than 3 mi. is possible. Under these conditions the derailing of an engine causes no damage or delay, as a tie-up of the line for an hour or two is permissible. There is, therefore, little necessity for keeping the track in good condition; in fact, it gets attention only when badly needed or when labor is available for that work.

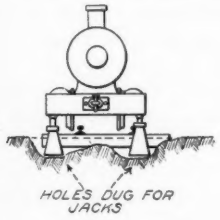


FIG. 1

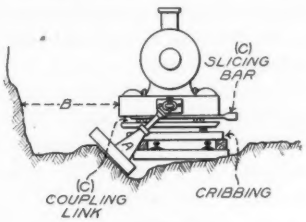


FIG. 2

FIG. 1. METHOD OF RAISING ENGINE WITH JACKS
FIG. 2. CRIBBING USED IN PLACING ENGINE ON TRACK

The smaller engines, having but 4 drivers, climb up on the rails almost as fast as they fall off, and when the engineer finds his train wandering from the crooked and narrow path, his only annoyance arises from the possibility of being late for lunch.

I have seen a driver, after uncoupling the engine, gather a few stones about the size of his head and place them in front of his wheels in a suitable manner. He then drove the engine up on the stones, from the top of which it slid over on the rails with a lurch. In less than 5 min. he was on his way.

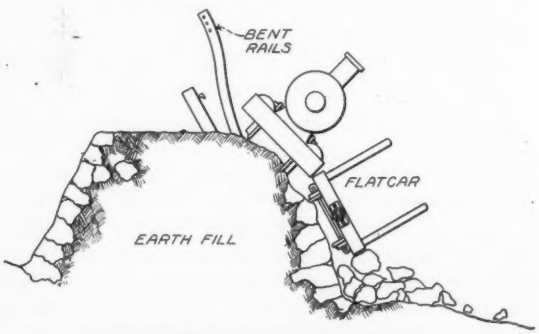


FIG. 3. DERAILED ENGINE WITH CAR SUPPORT

Engines having 6 drivers cannot be handled so easily, and therefore carry a pair of screw jacks. The engineer and fireman each operate a jack, raising one end of the engine as shown in Fig. 1.

When the wheels nearest the end being lifted, are raised above the rails, cribbing is inserted, as in Fig. 2, and the jacks removed.

The engine is then moved sidewise by a single jack, A, Fig. 2, inserted at an angle. Where the work occurs in a cutting, the jack can be applied at B, and the thrust be taken by the wall of the cut. Old ties, firewood or any available matter, forms the cribbing; lacking these, car stakes are taken from the train.

To make the engine slip easily over the crib, some metal objects are inserted at C, such as coupling links and slicing bars.

When the wheels are brought over the rails, the jacks are again applied, as in Fig. 1, the cribbing removed and the engine lowered to the rails. If only one end of the engine was derailed, the work is now finished, but if all the wheels were off, the rear end of the engine must be handled the same way.

On one occasion, the engineer was in a hurry to get home and took chances; the result was a bad mess, which I had to go out and clean up.

The engine was pushing one empty car, which ran off the fill in the position shown in Fig. 3, where it formed a support for the engine, which otherwise would have fallen about 15 ft. and capsized.

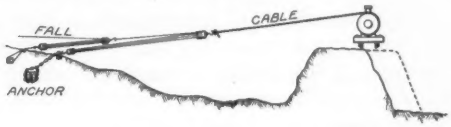


FIG. 4. USING CABLE AND TACKLE BLOCKS TO RIGHT LOCOMOTIVE

The first thing I did was to blow off the boiler, thus lightening it.

It was impossible to disturb anything with jacks without great danger, so we made the rig shown in Fig. 4. The cable was bent around the boiler and made fast, and a dozen men on the fall soon pulled the engine up straight. I then had the side of the fill built out as shown by the dotted lines, forming a floor under the overhanging wheels.

FOR RECORDING on one chart the water consumption, coal consumption, evaporation accomplishment and use or waste of water from the boiler, George B. Wilcox of Saginaw, Mich., has devised an instrument called an Econograph.

The water pointer and pen, connected through a train of gears to a water-weigher or flow meter, traces a line whose ordinate shows the total water used, and its inclination to the horizontal at any time, the rate of use. The same things are shown for the coal by a coal line, this pen being actuated by connection to the scales or stoker or a tripper which counts the number of barrow or cart loads delivered to the fireman.

For the evaporative performance, a steady line is drawn so long as performance is at or above a desired standard. If it falls below, the pen is raised, and returns only when evaporation again reaches standard, so that a break in the line indicates bad conditions somewhere. The fourth pen is connected by electric circuit to the blowoff and other outlet valves, and indicates by a jog in the line when any valve is opened which withdraws unevaporated water from the boiler.

By this means a 24-hr. record is made for the information of the plant manager or chief engineer.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Water Rheostats

REQUIREMENTS FOR PROPER CONSTRUCTION AND OPERATION; RESULTS OF TESTS ON WATER RHEOSTAT USED IN CONNECTION WITH HYDRO-ELECTRIC PLANT. BY N. L. REA

IT IS often necessary to make heat-run tests on large generators after installation, which usually necessitate some form of artificial load. Many experiments have been made to devise a cheap, reliable, and satisfactory form of temporary water rheostat.

For voltages below 2300, salt must be used to lower the water resistance and therefore it is necessary to build a tank to hold the electrolyte. In the majority of cases, however, it is possible to step up the voltage and to connect the artificial load to the high-tension side of the transformers.

Water rheostats have been used satisfactorily for voltages as high as 45,000. Water rheostats for hydro-electric plants are usually installed either in the tail-

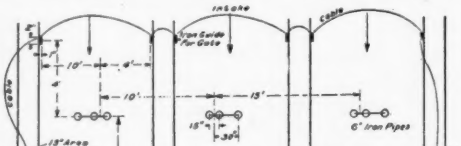


FIG. 1. ARRANGEMENT OF PIPE ELECTRODES FOR WATER RHEOSTAT

race or in the forebay; and many experiments on spacing, type of electrodes, etc., have disclosed some surprising results. For use as electrodes, the following have been tried: spheres, copper bar or rods, carbon rods, iron plates, and iron pipes. The 2 latter give good results and are usually available in a power-station. Rectangular plates are used which are hung from one corner by a rope to a strain insulator, or the rope may be tied to a standard line insulator installed horizontally. With this latter arrangement, it is, of course, necessary to disconnect the rheostat when making adjustments.

It has been found that the spacing of the plates has little, if any, influence on the load capacity. The surface contact resistance is the governing factor, for the same electrode surface passes practically the same current whether the plates are 5 or 50 ft. apart. In a 3-phase circuit, plates arranged in a straight line with uneven spacing give apparently the same degree of balanced load as is furnished by a carefully arranged equilateral triangle.

When it is necessary to use more than one electrode per phase, more current will be transmitted if the connected plates are separated several feet than if they hang close together. If possible, the electrodes should be hung in running water to carry away the steam and gases which form on their surfaces; otherwise, arcing may be caused by this gas blowing the water away from the electrodes. In some cases the rheostat has been

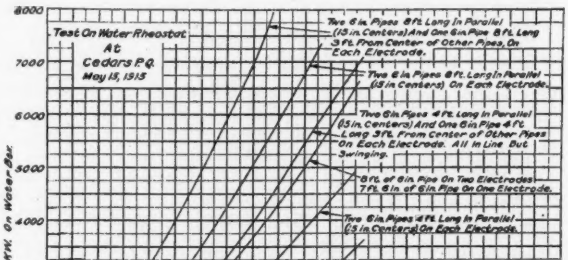

Test On Water Rheostat At Cedars P.Q. May 15, 1915
Two 6 in. Pipes 8 Ft. Long In Parallel (13 in. Centers) And One 6 in. Pipe 8 Ft. Long 3 Ft. From Center of Other Pipes, On Each Electrode.
Two 6 in. Pipes 8 Ft. Long In Parallel (8 in. Centers) On Each Electrode.
Two 6 in. Pipes 4 Ft. Long In Parallel (8 in. Centers) And One 6 in. Pipe 4 Ft. Long 3 Ft. From Center of Other Pipes On Each Electrode. All In Line But Swinging.
8 Ft. of 6 in. Pipe On Two Electrodes 7 Ft. 6 in. of 6 in. Pipe On One Electrode.
Two 6 in. Pipes 4 Ft. Long In Parallel (8 in. Centers) On Each Electrode.
4 Ft. of 6 in. Pipe On Each Electrode
K.W. On Water-Rheostat
Volts
8000
7000
6000
5000
4000
3000
2000
1000
0
2000
3000
4000
5000
6000
7000
8000
9000

FIG. 2. TESTS ON WATER RHEOSTAT SHOWN IN FIG. 1

placed in the tail-race, and protected from waves by a hollow square of timbers. These timbers must, however, be kept at some little distance from the electrodes or they will be carbonized by the current flowing over them and eventually take fire. If the electrodes are installed inside the building, care must be taken to eliminate the possibility of accidental shocks to operator.

It is advisable that all adjacent metal parts of the building be connected together with cables as a protection to persons and to prevent burning between the iron and concrete.

A series of tests was recently made at the Cedar Rapids Mfg. & Power Co. plant. Figure 1 is a sketch showing the arrangement of pipe electrodes used in this particular case, and Fig. 2 gives the curves

resulting from the test. This water rheostat was located in the head-race and arranged as shown in Fig. 1. About 1000 cu. ft. of water flowed through each bay per second while the rheostat was being tested. A large part of the surface of the steel headgates is always under water, so that these gates and all other iron in the water around the rheostat were connected together by cables as shown in the sketch. A loose connection showed that considerable current was carried by these cables. The steel gates themselves are connected by shafting. No trouble, whatever, was found in keeping the load balanced with the same length of pipe electrode in each bay; there was no steaming at the pipes, and one could not tell by looking at them when the load was on or off the rheostat.

The curves were taken while experimenting on the number and length of electrodes necessary for this series of tests.

Under some conditions it is impossible to secure satisfactory results with a temporary arrangement such as just outlined; or again, it may be desirable to have a permanent rheostat as part of the power-station equipment.

The first cost and maintenance of a permanent rheostat is small and the expenditure is usually warranted by the advantages offered by the equipment. This is especially true for hydro-electric stations of any considerable size, or for those which contain several units. A good rheostat gives a ready and convenient means for testing machines or adjusting governors without interfering with the commercial operation of the power-station.

Much thought, time, and money have been expended in the past on various schemes of water rheostat design, and the same ground has been covered many times by different engineers. The natural way of approaching the problem is to construct some form of tank provided with an overflow and with a pipe for admitting fresh water at a point opposite the overflow. Then electrodes of pipe or iron plates are hung in the tank with ropes and strain insulators. This arrangement has the same capacity limitations as has the temporary rheostat, for satisfactory service is impossible when violent gassing (and consequent arcing at the electrodes) takes place. This arcing usually occurs at lower capacities in tank rheostats than in temporary outfits, due to the smaller amount and the poorer distribution of the fresh water.

Errors are frequently found in the design and construction of tanks, in the arrangement of electrodes, and in the manner of admitting cooling water. Some of the more common errors will be named, and the remedies developed by experience with various types will be described.

Wooden tanks have been constructed using the iron hoops common to stave construction, only to find that the current came through between the staves to the iron hoops and quickly burned many holes. This trouble can be overcome by several inside bands of flat bar iron against the inside surface of the tank. These bars must be firmly secured in place by bolts and vertical iron straps connecting the several bands together.

Many of these tanks have been carefully insulated from the ground which is unnecessary as the rheostat operates as well, and is much safer, with the tank grounded. Boiler plate or concrete construction is preferable to wood. It is advisable that metal reinforcing be omitted from concrete tanks, due to the lack of definite data on the effect of current on this reinforcement.

It has been found that a more intelligent use of cooling water will overcome arcing at the electrodes and allow of a much higher load capacity. Two schemes have been used successfully. Both of them have, as a basis, a false bottom in a portion of the tank with some means for admitting the cooling water under pressure to this space.

The first rheostat constructed along these lines had 3 vertical wooden posts attached to the bottom of the tank and the pipe electrodes were slid over the posts. Several small holes were drilled in this false bottom around these posts. The pipes were kept from swinging and the jets of water played over the electrode surface, cooling and sweeping away any gas or steam.

In a later rheostat, the posts were made ½ in. smaller in diameter than the pipes and a large hole was drilled through them into the cold water space under the false bottom. The electrodes were capped to compel the cooling water to flow down between the outside of the post and the inside surface of the pipe.

With this arrangement the tank can be liberally salted, and loads up to 15,000 kw. at 13,000 v. have been carried without the least trouble from arcing.—General Electric Review.

Conclusions of an investigation carried on by Prof. T. D. Yensen, of the University of Illinois, on magnetic and other properties of iron-silicon alloys melted in vacuum, state that by this method of vacuum melting a decidedly purer product is obtained than has been possible heretofore, consequently the conclusions drawn with regard to the effect of silicon upon iron are more definite than have hitherto been possible. Silicon has a double effect upon iron; part combines with the iron, remaining in solid solution, while a smaller part reduces the iron oxide present.

Tensile strength of the product follows in general the same law as alloys made under ordinary conditions, but the ductility of the vacuum product is much greater, especially in the alloy below 2 per cent silicon and above 3 per cent. Maximum tensile strength occurs at 4.5 per cent silicon, and is 105,000 lb.

The limit of forgeability lies between 7 and 8 per cent silicon. There is a critical range between 2.55 and 2.6 per cent, in which alloys are exceedingly brittle and unworkable.

As to magnetic properties, the best alloys are obtained with 0.15 and 3.40 per cent silicon after annealing at 1100 deg. C. Maximum permeability for both these alloys is about 50,000, and at a flux density of 10,000 and 15,000, the hysteresis loss is about ⅛ and ⅓ the loss for commercial silicon steel at like densities.

Specific electrical resistance increases about 13 microhms for the first one per cent silicon, and the increase is about 11 microhms for each additional per cent, so that the 3.4 per cent alloy has a resistance nearly 5 times that of the 0.15 per cent alloy.

The results have not yet shown how to get a commercial alloy, but have proved definitely the properties of such an alloy when secured.

Batteries on the Peaks

REASONS FOR A FLOATING STORAGE BATTERY TO EVEN UP GENERATOR LOAD. BY G. H. KIMBALL

RICHARDS, the oiler, was on the lookout for more information, and he said to Wallace, one day: "Hall, the electrician, was telling about some stations where there are storage batteries. Have you had any experiences with them?"

The engineer thought a minute, and then said:

"That was one of the features of the Glendale power station, a battery of about 200-amp.-hr. capacity."

"What do you mean by that?" asked the oiler.

"When fully charged, it could deliver 200 amp. for 1 hr."

"But what's the use of such a battery?" asked Richards. "You have to take power to charge it up and then you take it out again; why not put in engines enough to carry the load all of the time?"

"If those who plan a station can tell to a certainty the range of the load at different times of the year, they can and usually do provide engines enough to do the work, but sometimes, if a certain amount of power is needed during the period of maximum load, a battery will be a better investment than the engines.

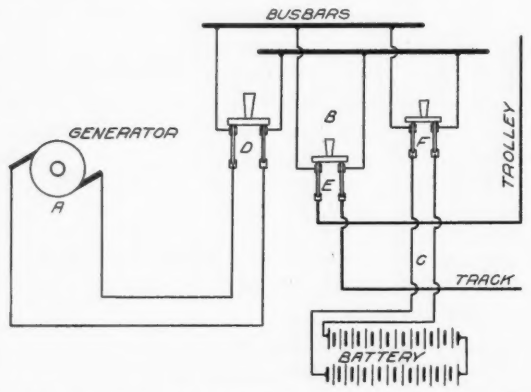


FIG. 1. PRINCIPLE OF CONNECTIONS OF GENERATOR BUSES, FEEDERS AND BATTERY

"Some plants are equipped with batteries to use in case of failure of the power so that the service of the cars or lights may not be interrupted and this is the only reason that they are installed in such plants. Others use them for emergencies when the load increases very rapidly, as in a large city lighting station supplying direct current in the center of the business district. Also in railway plants they are put on to help out the engines during the peak loads automatically.

"In a station where the load, we will say, is 500 kw. in the evening, while in the day time it is but 200, if we have engine capacity enough to handle the heavier load, then more than half of it must remain idle during the day, and there must be banked fires in the boiler room, which means some waste of coal.

"Instead of units aggregating 500 kw., suppose there were installed enough to carry 300 kw., and a battery capable of carrying the other 200 kw. during the period of heavy load. During the period of light load, the battery could be charged so that instead of a day load of 200 kw., there would be one of 275, and thus the load on the engines would be more evenly distributed throughout the 24 hr. Besides this, the battery can be called upon to carry a good portion of the load alone, if anything should happen to cripple the engines for a short time, as it is ready at a moment's notice to connect on, while an extra engine must be warmed up, and it may take 10 min. to get it onto the line."

"Why did they have the battery at the Glendale Station?" asked the oiler.

"Principally to smooth out the peaks of the railway load," was the engineer's answer.

"The railway and lighting machines were belted to the same shaft, as you know, and as there were not many cars running at any time, there would be a heavy load, and then none at all. This would continue for most of the day so that the engines and water wheels were affected by variable loads during the time in question."

"I do not understand how the battery can help out a machine," said Richards. "Will the two work together automatically?"

The engineer began to explain: "At that plant the battery was connected as I have shown in the sketch, Fig. 1. Here you will see the generator and the wires, A, leading from it to the busbars through the switch, D. The lines, B, lead to the railway trolley and track through the switch, E, from the busbars and also from them the wires, C, supply the battery through the switch, F.

"The battery had 252 cells which when fully charged would give about 2.3 volts per cell, and these placed in series would give a total voltage of about 600 at no load.

"The generators were the ordinary compound wound machine with the terminals arranged so that the series coils could be cut out so that it would then act as a shunt machine."

The water seemed to be getting too deep for the oiler, for he said: "Would you mind explaining about the difference in the 2 windings, for I cannot see it."

"Almost every direct current machine has around the field magnets," resumed Wallace, "two coils, one of small wire and one of heavy; the small wire coils take a portion of the main current of the machine under the control of the rheostat on the switchboard, to excite the fields so that the machine may generate. You know how you can vary the voltage by cutting in or out the resistance by the rheostat handle and you vary the amount of current passing around the coils of small wire, or they are called the shunt coils. In the heavier, or series coils, as they are called, the main current passes from the brushes, through them, thence to the line, and, if the current is heavy the effect will be to make the fields have more magnetism, which will increase the voltage in the armature. Each machine is wound for a certain rise in voltage from no load to full load, to make up for the drop in voltage on the line.

"Now suppose that the series coils are removed, then the machine will have nothing to strengthen the fields so that when a load comes on the voltage will drop and then if the load is removed voltage will rise to the original value."

"But why did you cut the series coils out when the battery was working?"

"When a battery is run with a compound wound machine, the voltage does not drop when the load comes on, so that without help of additional apparatus called a booster the battery will not take any of the load, and consequently will be of no assistance to the engine or whatever turns the generator.

"Now, if we look at the sketch again, considering the machine as shunt wound, the battery charged and the voltage at no load as 600; if there is a load on the line, B, the machine will take a part of it and at the same time will drop slightly, and when it does, the battery will begin to feed into the busbars and will also take some of the load. Suppose there is a load for 15 min. on the line, B, of 200 amp.; then the machine would take 150 amp. of it and the voltage having dropped to 575, the battery would take the other 50 amp. Then the load going off, the voltage would rise to 600 again and the battery would charge perhaps 50 amp. Thus the machine is doing some work all of the time, and a graphic ammeter record would show a fairly even line instead of points running from no load to full load most of the time.

"The battery at Glendale was of the greatest assistance when the water wheels were carrying all of the load, for they cannot take care of the sudden changes in the load as quickly as an engine, so that when the railway load went on and off the shocks were taken up in the battery and thus the speed of the jack shaft did not change much."

"Does the battery require very much care and attention?" asked Richards.

"Yes," answered the engineer, "the first cost is high and the battery must be looked after or it will soon depreciate."

"Do the cells ever wear out?" again asked the oiler.

"The cell consists of a glass jar containing 2 sets of plates, one of which is called the positive and the other the negative. The negative plates will outwear several sets of positives so the positive plates were the only ones that I had to have renewed at the plant in question.

"The plates are made with a lead base and the active material is contained in small buttons in the positive plates and it is this material that is thrown from the plates when there is either a charge or discharge of the battery. This will fall to the bottom of the cell and gradually piles up higher and higher until it has to be removed, for if it touches the plates it will short-circuit the cell."

"How can you tell when the battery is fully charged, or is not as strong as it should be?" was the next question put to Wallace.

"The action of the battery is wholly chemical so that some things which would seem possible to you would not work out in it," said Wallace. "Take, for instance, the fact that the plates are surrounded by a liquid that is an excellent conductor of electricity, yet there will be no short circuiting between them unless a piece of metal or the sediment bridges the space between them."

"What is the liquid?" said Richards.

"It is composed of part water and part sulphuric acid," said the engineer, "and the 2 are mixed so as to give liquid having a specific gravity of 1.21, or somewhat more than that for water, which is 1. By this I mean that the electrolyte is denser than water, a cubic foot weighs more than the same volume of water.

"Then coming to your question as to how the strength of the battery can be determined, we have an instrument called a hydrometer for measuring the density of the liquid. When the battery is fully charged the hydrometer, which floats in the cell, will show a point at about 1.21 at the surface of the electrolyte, and as the battery discharges, this will fall until it has reached the point of 1.185, when it should be charged up again and not left in a discharged condition.

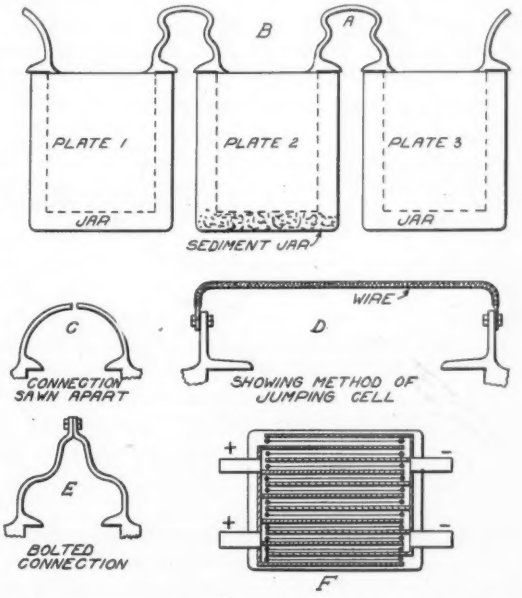


FIG. 2. CONNECTIONS OF CELLS AND PLAN OF PLATES AND SPACERS

"At the Glendale plant, the aim was to keep the gravity of the battery at the same point all the time, and when a battery is connected and operated in this way it is called a floating battery."

"How could you keep the battery charged up all day?" asked the oiler.

"By adjusting the generator voltage," was the answer.

"As the machine warmed up there would be some drop in the voltage and resistance was cut out to compensate for this and, if the machine is not run too long, there will be no great drop in the battery. It was our custom to run one generator in the daytime and cut the other in at night.

"We also made some other demands of the battery, as sometimes the water in the river would slack up for a short time and by cutting down the generator voltage the battery could be made to take a larger part of the load until the water came back, after which if the gen-

erator voltage was raised, it would use the extra water in charging. This did not pay, if the battery had to be drawn down too much, but we often found times when it was feasible."

"When finding the gravity of the battery, did you have to try the hydrometer in all of the cells" asked the oiler, who was bound to find out all that he could.

"That is what we did at first," said the engineer; "and then when the strength of the electrolyte in all of the cells is nearly the same, it is customary to take one convenient cell to use as a pilot and then the hourly readings of the battery can be taken from this cell and the battery tested as a whole once each week.

"There are 2 outside influences that affect the gravity of the battery, and those are the temperature and the height of the liquid. The water evaporates slowly and more has to be added as needed for the tops of the plates must not become bare.

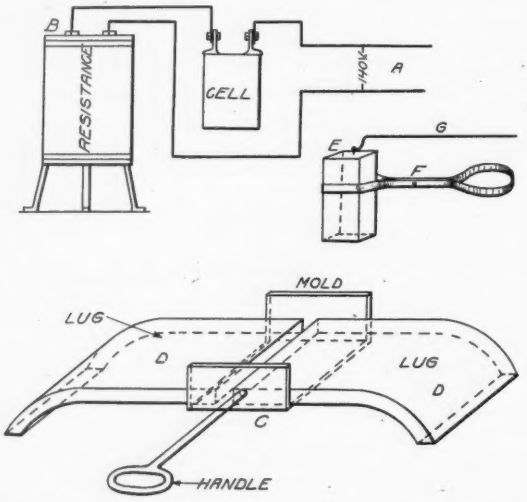


FIG. 3. DETAILS OF LEAD BURNING AND CHARGING A SINGLE CELL

"Thus in the case of the pilot cell, as the level of the electrolyte lowers, the gravity will read higher, and if there is a rise in the temperature, the gravity will read lower, and vice versa. So to overcome this in the pilot cell there is an arrangement to keep the water always at the same point with a supply from a small reservoir above the cell, and it is controlled by 2 glass floats. For the change in temperature a hydrometer is made that will compensate for the changes in temperature so that the pilot cell is a good example of the condition of the whole battery."

"If it is necessary to change any of the plates in the cells, is it much of a job to do the work?" was Richard's next query.

"I cannot say that it is a very hard job," replied Wallace, "but it is like many things that one has to do with electricity that seem almost impossible if you have never done them before. At first there was one cell that used up its positive plates quickly and Phillips, the manager, came down to put in some new positives and the first thing that he did was to cut out the cell."

"How did he go to work to do that?" asked the oiler.

"Well," said the engineer, drawing the sketch, Fig. 2, "the 3 cells marked B are in the battery, and suppose that the cell marked 2 is the one to have the plates renewed; to disconnect the cell from the others, he sawed the lead connections A at the middle point, as shown at C, and bored holes in them."

"Would not that cut the battery in two?" asked Richards.

"Yes, it did," said Wallace, "and as we wished to use the battery that night, we made some jumpers out of No. 4 wire and bent them so that they would fit down over the lugs, and then the bolts were put in as shown at D, and current could flow as before with the drop in voltage due to the absence of the cell.

"Having done this, the other cell could now be fixed up. The plates were lifted out and the acid drawn off in order to remove the sediment that is shown in the bottom of cell No. 2 and which is accumulating all of the time. When this gets up as high as is shown in the sketch, it will short circuit the cell."

"Where does that sediment come from?" asked the oiler.

"From the positive plates. It is lead oxide. The buttons in the plates are filled with this material, and when the cell operates, this is released and falls to the bottom."

"Having washed out the cell, Phillips now had the negative plates put in and then the new set of positives, which fitted in like F, which is a sketch of the plates from the top; you will see that there are 6 of each, although there may be almost any number."

Richards was much interested in the sketches and he soon burst out with: "What is that piece between each plate with a round piece at the ends?"

The engineer explained: "That is the separator and is made of a very thin board, and the pins at the ends are the dowels. It is used to keep the plates from touching each other as they would if they should buckle, as they sometimes do when the current flows through them very fast," was the answer.

"After pouring the acid back, was the cell ready for work the same as a Leclanche cell would be?" was asked.

"The hardest part of the work was now to come," said Wallace. "For it must be charged until the gravity is brought up to 1.21, and to do this, when the cars were in, the jumpers were removed and the lugs bolted together as shown at E, and then when the whole battery was charging this cell received a charge with the rest, then in the morning, when the battery was needed on the line again, the cell was cut out and left standing during the day, so that it would not discharge any. The next night the operation was repeated until the cell was fully charged, and then it could be connected up permanently."

Richards then spoke up: "Before the cell was cut out the connections at A were solid, were they not?"

"Yes," answered the engineer.

"Yet afterwards you used the bolts to hold them. Which is the better way?"

"Both are used in small batteries, but in those where the current is heavy, as in railway work, the bolted connections are not as good as the solid, and they are only used in small batteries used for lighting purposes."

"How are the solid connections made?" asked Richards.

Wallace replied: "By an operation called burning, in which a mold is used and the lead is melted so that it will run together and be like a solid piece when it has cooled."

"How is the heat applied when the glass jars are so near?"

"Principally by the use of a blow pipe using the flame of oxygen and hydrogen, which makes a small needle-like flame that can be applied to a very small space."

"And how is the mold put on?" was the next question.

The engineer produced the sketch shown in Fig. 3. "Here at C the lugs D bend up so that their ends are about ⅛ in. apart and the mold, which is open at the sides and is as long as the lugs are wide, is placed under them and blocked up from the plates. Then when the blow pipe is ready the operator takes a stick of lead in one hand and applies the flame to the ends of the lugs, which quickly melts them; he then melts enough off the stick of lead to fill in the space between and, when all of it has run together, he withdraws the flame and, as soon as the lead has cooled, the joint is done. When putting up new batteries, this method is used to make the connections."

"Did you ever have to change any plates after the manager did?" asked the oiler.

"About a year after," said Wallace, "there were 1 or 2 cells to fix up, and with some advice from the battery company's engineer I attempted to do the job myself.

"Everything went well until the time came to charge the cell, and as I did not like the idea of charging it nights and then having it stand all day, I borrowed a resistance from the car barn that was used in connection with the arc head lights and took 2 wires from the main battery, so that I would get a voltage of about 140 across them, and connected them to the cell and resistance as shown at A in Fig. 3."

"Would the resistance at B cut down the voltage enough?" asked the oiler.

"Yes, and if it were higher than that of the cell, the resistance of the cell itself would hold down the voltage to the right amount, and as the resistance took about 2 amp., the cell would charge at that rate. This was rather low, but it had this advantage; it was constant, and by putting the hydrometer in it, I could see a gradual rise each day, and after some days of this charging the positive plates began to take a chocolate color, which is the right one for them to have. When the time came for the weekly overcharge for the battery, I had the cell cut in so that it could take 50 amperes for several hours, and as it began to throw off gas freely I considered it all right to leave in with the rest."

"What is the cause of the gas?"

The engineer answered: "When the cells are in proper condition and are fully charged, the plates will give off bubbles of gas which rise to the surface of the cell and float off in the air. If you have no hydrometer when charging, the production of this gas is a sign that the battery is fully charged. It is also explosive and no flame should be brought near it."

"When you had the cell properly charged, did you have a blow pipe to melt in the joints with?" asked Richards.

"No," was the reply. "And the battery engineer advised me to use an electric arc which can be formed by short circuiting about 8 cells back of the one to be connected in. This is done by taking a wire and clamping it to the lug of the eighth cell, counting in the direction that the positive connections go and clamping the wire to a positive connection.

"Having adjusted the mold as before, I made an electrode by taking a carbon brush and connecting the wire to the pigtail and then made a holder for the brush of some strap iron as shown at in Fig. 3. The curved part I wound with tape to insulate it, and then putting on a pair of colored glasses, I was ready to burn the joint.

"You will understand how this was made by looking at F where E is the brush with the wire G leading from it. The handle was made by bending the piece of strap iron and putting a bolt through it so that the brush would be held firmly as in a pair of tongs."

"Was the arc a good thing to use?" asked the oiler.

"As far as heat went there was plenty," said Wallace, "but the trouble was that there was too much heat all at once, and it was very different from the blow pipe flame, which would melt a small spot at once, for the arc would melt the whole surface of the lug inside of the mold if it was not drawn away in time, and it required a little practice to keep the brush touching just enough to run the joint, and no more. However, I was able to make a good joint for connection even if it did not look as smooth as the others. By using a file it was finished up so that it passed inspection."

"If anyone had ever told me before that there was so much to a storage battery, I should not have believed it to be possible," said the oiler at the conclusion of these remarks.

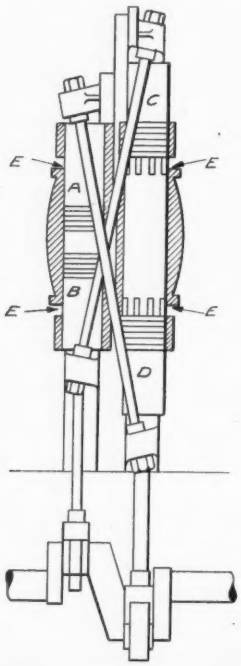
"Yet in spite of all that I have told concerning my experiences," said the engineer, "there is a great deal more to be learned about them, and I have simply been concerned with the operating end."

THE AMERICAN ASSOCIATION OF ENGINEERS announces that it has signed a 5-yr. lease for suite 601-604 at 29 So. LaSalle St., Chicago, Ill. This is the second time in 9 mo. the new society has been compelled to enlarge its quarters. It has now a membership of 500, 65 per cent of which is in and near Chicago, and the remaining 35 per cent is scattered throughout the United States, Canada, England, Philippine Islands and even in South America. The enthusiasm shown by the members in the Chicago Alpha Chapter is remarkable. Its semi-monthly meetings are attended by never less than 100. At a recent meeting, 87 new members were initiated in the instructive philosophic ritual through which this new association is promulgating its lessons in co-operation. These lectures are highly complimented, particularly by engineers of long experience and high standing as conveying a message for a higher standard of ethics between engineers and those who profit by their endeavors. The new association seems to have found a field of activity different from those of the older societies.

Foreign Development in the Power Plant Field

THE FULLAGAR GAS MOTOR. BY J. H. BLAKEY.

THE arrangement of the Fullagar gas motor is shown by the accompanying diagram. Four pistons, A, B, C and D, move in 2 parallel cylinders, and are connected by oblique rods. The motor works on the 2-cycle principle. The explosive mixture contained between the pistons A and B, situated as shown in the diagram, on being ignited drives these pistons apart; at the same time pistons C and D are brought together and so compress the gas mixture which has been introduced between them when they reached the end of the stroke. The gases resulting from the explosion between A and B escape, when these pistons are at the end of their stroke, by openings E, E, at the circumference of the



cylinders. At this moment a current of air is forced between the pistons by means of an air pump for the purpose of driving out any gas which may remain. Now pistons C and D continue their outward motion and thus cause the compression of the mixture between A and B. Air is now driven into the cylinder, C-D, by pumps (not shown); these pumps are actuated by a lever motion in motors of considerable power, and in smaller motors running at high speed they may be arranged as a prolongation of the cylinder and operated directly by the piston.

The arrangement of this motor is open to the criticism that a large amount of friction will result from the obliquity of the rods connecting the pistons. Against this may be set the fact that this arrangement gives 4 pistons for only 2 cylinders, and that with 4 pistons in the ordinary arrangement there are 4 connecting rods, each one of which is a source of a loss of power. It may be supposed, therefore, that the friction losses in the 2 cases are on the whole very similar. On the other hand, this arrangement presents numerous advantages. In reducing the number of cylinders, heat losses by transmission and radiation are also reduced; it does away with cylinder covers and joints, which are liable to be a source of trouble under high pressure; the frame and foundation are subjected to no vertical stresses; the reactions of the explosions are carried only by the oblique rods and the connecting rods, and not by the frame. It is true, however, that the frame and foundation receive transverse reactions on account of the obliquity of the rods connecting the piston; but as the obliquity is small, the reactions are also small. Further, the stress produced by the explosions upon the pistons is transmitted equally and at the same moment upon the 2 cranks and upon the bearings, in opposite directions, so that the bearings have to support only the weight of the shaft. Finally, the cylinders are extremely simple in form, being nothing but a straight tube, without accessories of any kind or cavities in which the force of the explosion may be dissipated without producing energy.

For fixed motors of considerable power, 2 units of 2 cylinders each, giving 8 pistons, are arranged together; for still greater power, 3 or more units may operate one shaft. With 2 units—that is 4 cylinders, 8 pistons and 4 cranks—a motor is produced in which the weight per unit of power is from 35 to 50 per cent less than with the ordinary arrangement.

The first application of the system has been made at the power station of the Electric Supply Co. at Newcastle-on-Tyne, England. The motor installed here (2 units) weighs 20 tons, without the flywheel; it develops continuously 350 hp. upon the shaft; in this particular case, the weight is less than half that of an average motor developing the same power. It was subjected recently to a 30-hr. test by Professor Hopkinson, of the Armstrong College of Science, who found the thermal efficiency to be 37.6 per cent and the mechanical efficiency 90 per cent. This thermal efficiency is very high, having been exceeded only once (so far as the writer has been able to discover) by a Diesel motor whose efficiency was 38 per cent. The mechanical efficiency, however, is not unusual, as many triple expansion steam engines have a recorded mechanical efficiency of 95 per cent and even higher.

Correction Note

OUR ATTENTION has been called by Mr. Uehling to some omissions made in his manuscript and so published in the April 15 issue. These seriously affect the meaning he wished to convey and we print the corrected sentences below, the part which was omitted being in italics.

Page 382, first column, middle of next to last paragraph—"The per cent of CO_2 is a correct index to the volume of excess air and hence to the total weight of gas per pound of coal burned. *If we multiply the weight of flue gas produced per pound of coal burned* by its specific heat, etc."

Page 383, second column, starting with the eighth line—"the chimney draft is affected favorably by wasteful boiler operation *due to high stack temperature and unfavorably* due to a low per cent of CO_2, etc."

Brine-Coil Defrosting System

COMPLETE EQUIPMENT READILY INSTALLED AT LOW COST. BY R. B.

FOLLOWING is a description of a brine-coil defrosting system which we have been using with great success in our ice-storage rooms. I have never seen this system in use elsewhere, nor have I seen a description of one, so thought it might prove of interest to Practical Engineer's readers.

Referring to the accompanying drawing and supposing that we want to defrost coil A (the hot-water tank being full of water at 180 deg. F., 82.22 deg. C., or higher), we close valves 1, 6, b, c, b^1 and c^1, leaving 3, 5, 2, a and a^1 open; have men each provided with a hand hammer placed about every 20 ft. along the coil to be defrosted. If the coils cannot be reached with the hammer a piece of wood 2 by 4 in. of sufficient length will do. Start the pump slowly, taking hot water through the 1¼-in. line. This hot water drives the cold brine before it and back to the brine tank.

As soon as the hot water reaches the first (lower) pipe, the man stationed at that point begins tapping lightly on the pipe. As the hot water moves along the pipe, follow it up rapidly, tapping the pipe all along the line. The work must be done rapidly, and the frost will drop off like spoiled fruit from a tree being violently shaken.

A little experience will soon teach the men to follow the hot water along the pipes as fast as it flows. The pump must be run slowly or the water will flow too fast.

As soon as the water has reached about the middle pipe of the coil, stop the pump, close valve 2, open valve 1, start pump, and the incoming cold brine will force the hot water ahead of it, thawing the remaining pipes in the coil.

A man should be stationed at valve 5, 6 and a^1. As soon as the brine that was originally in the coil (and which is now being forced along by the hot water which is in turn being forced through the coil by incoming cold brine) is all forced back to the brine tank, the pipe at valves 5 and a^1 will warm up. Valve 5 must now be immediately closed and drain valve 6 (to sewer) opened until the water has been all forced out, whereupon the pipe at a^1 and 5 will again become cold and valve 6 can be closed while 5 is opened, allowing the brine to return to the tank as usual. Care must be taken to close valve 5 at once when water begins coming to a^1 or the hot water will be forced into the brine tank, raising the temperature thereof and weakening the brine.

It is astonishing to see how quickly a number of coils can be defrosted with this system and the negligible rise in temperature of the rooms and brine while doing it.

For instance in one of our rooms containing 3 coils with a total of 1800 ft. of 2-in. pipe, the whole job is done in about 15 min. actual working time, and the temperature of the room rises from 24 deg. F. to 25 (—4.44 to —3.88 deg. C.), or may be 26 deg. F. (—3.33 deg. C.) (due to delays), and within 2 or 3 hr. is down to 24 deg. F. (—4.44 deg. C.) again. The rise in brine temperature is barely perceptible.

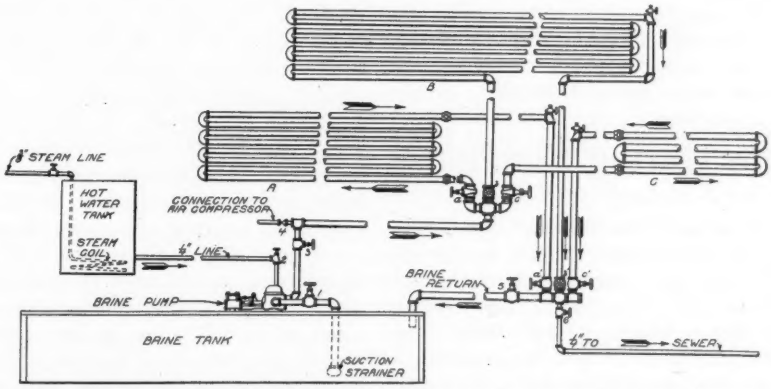


DIAGRAM OF EQUIPMENT AND CONNECTIONS OF BRINE COIL DEFROSTING SYSTEM

There is, of course, a slight waste of brine due to mixing of this with the water in the pipes, and to slight delays at the valves, but experience has proven that this does not amount to much in the run of a season.

We have 4 rooms containing a total of 8 coils consisting of 1800 ft. of 2-in. and 1500 ft. of 1¼-in. pipe, and can defrost all of them in 1 hr. from the time we start until we leave the rooms. The hot water tank holds about 400 gal., of which we usually use about 350 gal. on the job.

We use wagon men during their slack hours, so nothing has to be neglected in the engine or boiler rooms and no extra labor required.

Five men on the coils, one at the valves and one at the pump, are sufficient, and often we have not that many men.

I think this is far better than scraping or defrosting with steam, as the excessive condensation when using steam makes it a long job, besides raising the room temperatures beyond all reason.

All the expenses one need go to, to equip any such a system, is the hot-water tank, the pipe and fittings leading to the pump, and the valve, pipe and fittings for drainage to the sewer.

The air connection shown is intended to eliminate waste of brine, but the extra trouble in operating overbalances the saving made, in my opinion.

The idea being to blow the brine out of the coils, start pump, fill coils with hot water, blow hot water out of coils with air, start pump and fill coils with brine. This prevents contact of brine and water, but necessitates purging the coils of air after filling with brine.

Of course with the system as shown and only one pump, all the coils must be idle and closed while defrosting one coil.

With 2 pumps, however, and hot water connection and drains inside (next coils) of valves a, a^1, b, b^1, c and c^1, the brine could be kept circulating in all coils, except the one being defrosted, and each coil could be defrosted without interfering with the valves on the others.

This would call for more pipe, fittings, valves, etc. In the above no mention is made of a brine cooler for the reason that ours is situated between valve 5 and the brine tank, and is by-passed so that its low temperature can have no influence on any water that might pass through it. Where the water would have to go through the brine cooler, the ammonia would have to be closed off from it and its temperature allowed to rise to prevent freezing the water as it passed through.

Precautions During Erection

By J. P. Lisk

EVERY operating engineer that has had a commission to put a new steam power plant in service realizes that erecting men, steamfitters, machinists and boiler makers cannot give too much attention to the removal of scale, iron filings, chippings and other refuse from the pipe lines and apparatus that they erect.

The apparatus of which a steam generating, steam using, conveying and regulating plant is composed, consists of many machines widely differing in design and construction, from the most delicate to the coarsest specimens of the artisan's production.

Many of the machines are so delicate in structure and operation that even a grain of sand in a working part will render them useless for the service they were designed to perform, until it has been removed and the effect of its presence on the working surfaces has been adjusted by regrinding or new parts put in place.

Valve failure in a new plant is the chief difficulty experienced, for the reason that nearly all other failures have their origin in the defective condition of a valve.

To those familiar with the construction of valves it is obvious that if any foreign substance is left in a pipe line, it will eventually lodge in the recesses of a valve or one its seats, with the result that when the valve is operated the bearing parts are forced out of adjustment, thereby permitting the water, steam or other substance in the pipe, to enter the apparatus or pipes from which it was intended to be cut off.

The vital part of a valve is its seat, and whether the valve be large or small, it must be properly constructed, and of suitable material to withstand the eroding and corroding effects of the substance passing through it, as well as the wear and tear of operation. My experience has been that, within reasonable limits, the valves put on the market by the several manufacturers fulfill these conditions, and when properly installed give very little trouble.

After steam is up to pressure in the boilers, many adjustments of apparatus must be made, and it is very important that every valve shall give the operator absolute control of the line in which it is placed, otherwise serious damage may be done that will necessitate an emergency shutdown of the plant, or a possible loss of life.

An instance occurs to me now that happened in a plant in northern New York, a new 6-in. high-pressure steam line was installed, the drip valve got jammed, the water could not get out, water hammer started, and before the main stop valve could be reached, the line went to pieces, wrecking the engine room and maiming for life the engineer, the electrician and 2 steamfitters. Final investigation revealed the fact that carelessness on one man's part was responsible for the accident.

It may seem like extra and unnecessary work to the owner, when the erecting mechanics spend time cleaning the apparatus they are putting together; but that is the only way to insure against the starting up trouble, so generally accepted as unavoidable in new plants.

There is no denying the fact that Mr. Time Limit is largely responsible for our reputation for doing things, and Mr. Get Away With It has much to do with the profit and loss factor in our industries, particularly in the engineering branches. Mr. Reasonable Time went away for a vacation some years since, and has only been heard from at rare intervals, but will probably come back some time, and when he does, he will remove a great many of the friction spots from our industrial mechanism, that will again insure smooth operation, high quality apparatus and workmanship, and a pride in our accomplishments that under present conditions we do not feel.

One result of the demand for benzol and toluol for the manufacture of high explosives has been the reclaiming of these 2 liquids in the manufacture of coke. They are indispensable in making explosives, dyestuffs and other chemical products, and in appearance are similar to gasoline, but are driven off from coal when coke is made.

At the end of 1915, there were 19 new plants for benzol recovery in operation, the output for the year being nearly 14,000,000 gal. The annual capacity of the recovery plants now in operation is estimated at over 20,000,000 gal., and with the completion of plants now building will probably exceed 22,000,000.

Benzol is an excellent motor fuel, but the chief demand in normal times would be for manufacture of dyes and chemicals, which in the past have been largely imported from Germany, in one form or another. It would seem likely that after the demand for explosives ceases, the use for dye and chemical manufacture may profitably be developed.

Safeguarding Air Compressors*

PRECAUTIONS TO BE TAKEN IN THE OPERATION OF AIR COMPRESSSING MACHINERY. BY W. P. EALES†

UNSATISFACTORY performance of air compressors, and the hazard to those who operate them, are influenced by several factors and conditions. The main contributing causes are insufficient capacity, improper installation, unfavorable operating conditions, and negligent operation and maintenance.

The equipment must be adequate in size, and of proper design to deliver at normal speed the desired air volume and pressure.

Any speed in excess of 500 ft. of piston travel per minute should not be considered in accepting new installations. If the desired pressure at the point of delivery cannot be maintained without exceeding this speed, it is an indication of leaky valves or connections, or it shows that the compressor is too small for the requirements. Another feature that must be considered in connection with crank-and-flywheel air compressors is the rim speed of the flywheels. Under the most favorable operating conditions, the peripheral speed of solid cast-iron flywheels should not exceed 5000 ft. per min.; and when a wheel is "built up," or composed of parts that are joined together by bolts or in other ways, the maximum allowable speed should be determined with due reference to the construction of the wheel. A light wheel with flanged joints in the rim, for example, should not be run at a peripheral speed exceeding 3000 ft. per min. Where the duty of a compressor is subject to frequent and sudden changes the flywheel strain is unusually severe, and special allowance should be made in such a case in designing the wheel.

Air compressors should be erected and installed where the air is clean, cool, and free from dust and grit; and the power room or portion of the plant containing the compressor should be paved or floored so that it may be kept clean and free from dust. This precaution should be taken before the compressor is put in commission. It is not essential that it be located in a detached building, but when it is adjacent to a crusher building, or to a boiler room or any other department where dust is formed, the compressor room should be made dust proof.

When the compressors run continuously, or when the duty required of them is severe, it is vitally important to provide an adequate and unfailing supply of cooling water for the jacketed cylinders, cylinder heads, and intercoolers. If the supply of cooling water is limited, or if it is of doubtful quality (containing lime or mud, for example) it will pay at the time of installation to make special arrangements to secure a better supply, or to purify the supply that is already at hand. Impure water, and consequent deposits upon the interior cooling surfaces of the water jackets, often leads to overheating and causes difficulty and trouble. All overflow water from the cooling system should be piped in such a manner that it will be plainly visible to the attendant.

Direct-acting or straight-line types of compressors, with Corliss or other positive-motion suction and discharge valves, are best where the operating conditions are unfavorable, and where the skill and proficiency of the operatives are uncertain.

Air compressors have extremely variable loads, as a rule, and it is important that the foundations and fastenings be designed to take care of the fluctuation and prevent shock and vibration due to sudden stopping and starting when the pressure attains or falls below the normal at which the regulating device is adjusted. Pipe line should be free from sharp turns and angles, and should be arranged and secured so as to avoid excessive pulsation and vibration. Discharge pipes near the compressor should be covered or insulated, where exposed or easily accessible to the attendants. Provision should be made for the free expansion and contraction of the piping, because in some air lines, the range in temperature is fully as great as in a steam line.

Air tanks or receivers should be built of boiler plate of known physical qualities, and in accordance with boiler specifications. All openings for threaded pipes and connections should be reinforced, if necessary, to provide full threads. A spring pop safety valve with full size connection should be attached direct to the tank, and set to release at a pressure not exceeding the safe working pressure of the tank, using a safety factor of at least 5. Air tanks should be placed so that all their external surfaces can easily be exposed for examination. They should never be put underground, nor in other inaccessible places. Manholes should be provided in all tanks that are more than 36 in. in diameter, and handholes as a means of access to the interior should be provided in smaller tanks, so that the inspector can examine the interior in all cases. Every tank should also be fitted at its lowest point with a drain pipe not less than an inch in diameter, to carry off water and oil.

Stop valves in delivery lines should be omitted so far as possible. If stop valves cannot be avoided (which is sometimes the case where there is more than one compressor), they should be of gate or straight-way types. Globe valves should never be used in discharge lines. A spring pop safety valve, of sufficient area to release under an overload of 50 per cent, should be provided between the compressor and the stop valve.

Compressed air is properly regarded as a fairly safe power in comparison with steam or electricity, and yet there is an explosive hazard involved that is not very generally appreciated, and to guard against this, particular attention must be given to the internal lubrication of the cylinders and to the circulation and temperature of the cooling water. Steam cylinder oil should never be used in air cylinders. There is an intense dry heat in air cylinders, while in steam cylinders moisture is usually present to some extent. Oil will adhere to a dry surface when it would wash off of a similar surface that is moist or damp; and for this reason a smaller quantity of oil is sufficient in an air-compressor cylinder. A pint of air-cylinder oil should be ample for a 12-in. cylinder for 24 hr. running. It is sometimes difficult to adjust a gravity lubricator to this fineness of feed, and hence for this purpose forced-feed mechanical lubricators are recommended. There is danger in using too much oil in air cylinders. At a pressure of 100 lb. the temperature in an air cylinder often reaches 400 deg. F. (204.44 deg. C.), on account of interruption in the circulation of the cooling water; and owing to the likeli-

*Read before the National Safety Council at Philadelphia.
†Supervising Inspector, The Travelers Insurance Co.

hood of exposure to this intense heat the cylinder oil must be of such a nature that it will not volatilize, nor form a coating of carbon or burnt oil around the discharge valves and render them inoperative. The carbonized matter in the cylinder oil, liberated by the application of heat and deposited in the air passages and in and around the valves, may be removed quite well by the application of soap suds or soapy water. Kerosene oil should never be used for this purpose.

In some installations fusible plugs are provided in the bonnets or parts adjacent to the discharge valves, to relieve the pressure in case the temperature reaches 500 deg. F. (260 deg. C.)—the danger point. This is a wise precaution, and plugs of this kind should be adopted more generally.

Self oilers are advisable for the various external working parts of air compressors. They are efficient and economical.

All flywheels, rods, cranks, yokes, belts, and other moving parts should be effectively guarded. For this purpose an iron or wooden railing, 3½ ft. high, is sufficient, if it is of a permanent and substantial character, and placed so that there is a clearance of at least 15 in. between the railing and the moving part that is to be protected. If a clearance of this width cannot be had, the inclosures should extend to a height of at least 6 ft., and be filled in with a substantial wire-mesh screen.

Successful Small Air Lift

SINGLE WELL PUMPED FOR DOMESTIC SUPPLY BY GASOLINE ENGINE AND BELTED COMPRESSOR. BY H. L. HICKS

THE air lift is widely recognized as an efficient means of pumping water from deep wells, and one that is unusually free from trouble and interruption of the supply. Without the aid of supplementary "boosting" equipment, however, it is not generally considered practicable to deliver the water at any elevated distance from the well, particularly where there is a sharp bend in the discharge line.

FIG. 2. PUMPING UNIT INSTALLED IN THE OPEN

The installation pictured here (Fig. 1), is one that does accomplish this. Water is lifted from 35 to 44 ft. (depending on the season), is delivered a horizontal distance of 40 ft., elevated another vertical lift of 30 ft., and discharged after a second run of 7 ft. There are 3 right-angle bends in this eduction pipe. It is a good performance and shows the possibilities of a carefully designed air lift.

This plant is installed on a farm in Antelope Valley, California, and furnishes water for domestic purposes. The single well is 6 in. in diameter and 150 ft. deep. It was formerly pumped with a draw valve pump, and when this was removed the well was found to have become filled with sand to a depth of 70 ft. Upon the installation of the air lift, however, the sand was quickly removed without experiencing any difficulty. As a matter of fact, accumulation of sand is not possible with the air lift in operation.

The water level in the well varies slightly, the static head being 31 to 40 ft., according to the season. The average level is about 38 ft., with a pumping drop of 4 ft. Water is elevated to an 8000-gal. tank 30 ft. from the ground, making a total lift of 70 ft.

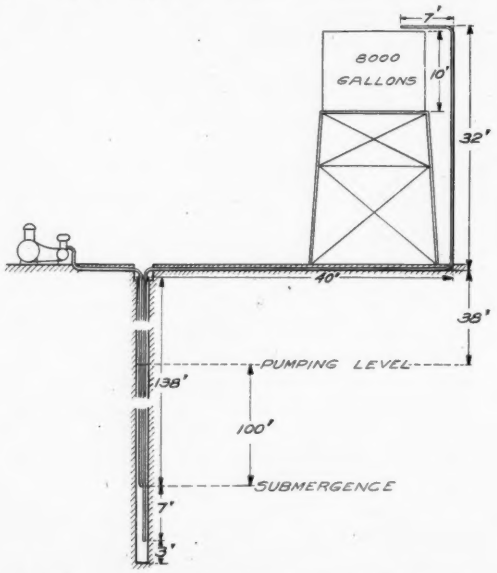


FIG. 1. LAYOUT OF SMALL AIR LIFT SYSTEM

The top of the well is 2 ft. below ground level and both air and water pipes are buried for protection. The discharge pipe is 2 in. in diameter and extends to within 3 ft. of the bottom of the well. It is fitted with a Lane Standard footpiece placed 7 ft. above the end of discharge pipe. The air supply pipe is ¾ in. in diameter. The running submergence is 100 ft. or about 59 per cent.

Air is supplied by an Ingersoll-Rand, 3½ by 4-in. Imperial vertical compressor with hopper cooled cylinder. This is belted to a Nonpareil, 2-hp. gasoline engine operating at 400 r.p.m. The belt pulleys of compressor and engine are 16 and 20 in. respectively, giving a compressor speed of 500 r.p.m. The air consumption is 11 cu. ft. of free air per minute at a pressure of 55 lb. per sq. in. This is based on a normal pressure of 44 lb. and a friction loss in the long discharge line of 25 per cent.

As Fig. 2 shows the wonderful climate of this particular section of the country has permitted the installation of the air compressing plant in the open, certainly an economy as far as the cost of housing goes.

This air lift pumping system delivers 39.8 gal. per min., and operates at an efficiency of 35 per cent.

This plant was designed by J. Warren Lane and installed for Mrs. Mae Whidden Taylor, Lancaster, Cal., by Harry Lee Martin.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Draft Control

EXPERIMENT AND observation have taught the writer that the proper manner to regulate the draft is so to adjust the damper that the proper volume of air is entering the bed of fuel through the grate, thereby burning the coal to the best advantage and not allowing it to smoulder along.

My method of accomplishing this with natural draft is as follows: The damper regulator is connected to operate the main damper, and the piston rod of the

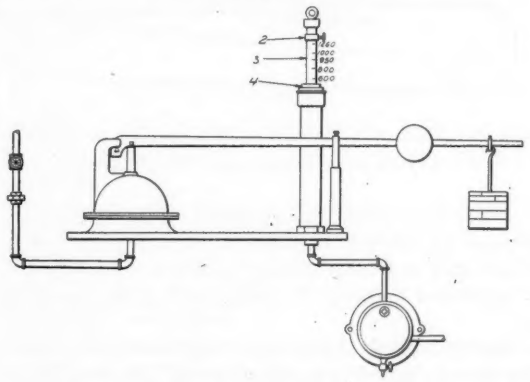


FIG. 1. DAMPER REGULATOR WITH GRADUATED PISTON ROD

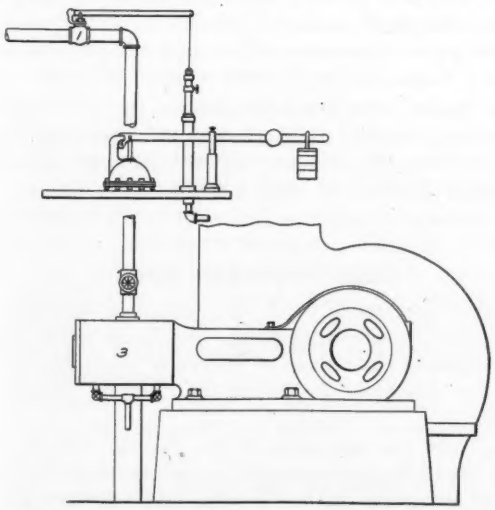


FIG. 2. DAMPER REGULATOR CONTROLLING FAN ENGINE SPEED

damper regulator is marked off as shown in Fig. 1. The clamp, 2, being moved up or down piston rod 3, as conditions require.

The engines are indicated and the loads figured inside of the first half hour of running and knowing the number of horsepower of steam required for other uses gives the total load.

The clamp, 2, is accordingly moved to the line representing that load and the travel of the damper limited to that distance between the clamp, 2, and the cap, 4. When conditions such as are affected by the weather or poor coal come up, the clamp, 2, is moved to allow a greater opening to the damper. This seldom comes up in this plant.

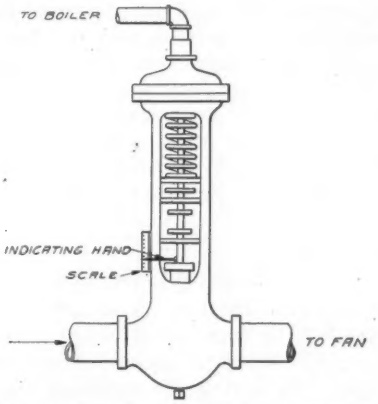


FIG. 3. SPRING BALANCE VALVE FOR FAN ENGINE CONTROL

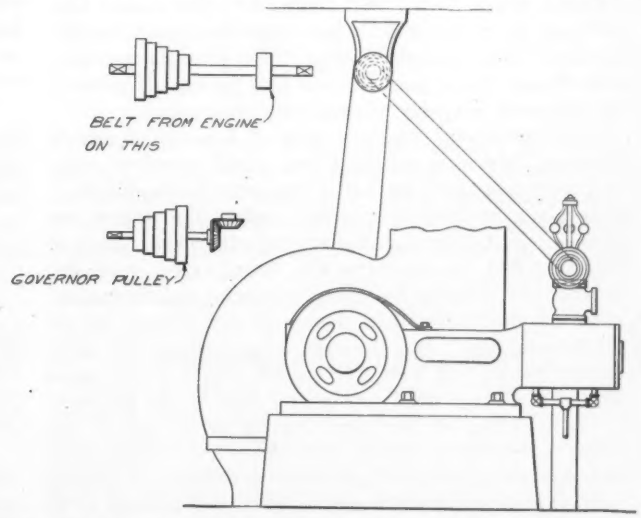


FIG. 4. COUNTER SHAFT WITH CONE PULLEYS FOR CHANGING ENGINE SPEED

Our 2 plants equipped with mechanical draft are independent of weather conditions, so the procedure is as follows: The main damper is secured wide open, and remains in that position except when fires

are banked. This makes it possible to have the balanced valve, 1, Fig. 2, control only the speed of the fan engines. The clamp, 2, Fig. 1, after being set at a given load does not have to be moved until the load changes.

In fitting up our new plant, I did not put in a damper regulator, but did provide a spring balanced valve, Fig. 3, to control the fan engine speed.

A pointer was put on the spindle and a scale marked off similar to the piston rod, 3, Fig. 1, and is used to determine the correct engine speed for the load carried.

In another plant I have a fan engine provided with a throttling governor. On this governor I put a 5-step cone pulley. A similar step cone pulley was mounted on a small counter shaft and belted as shown in Fig. 4.

The stroke of damper regulator is adjusted by the position of the clamp, 2, Fig. 1, the speed of the fan being controlled by the speed of the governor, by moving the belt from one step to another on the cone pulleys.

The result is that the fan has a constant speed for each load and slows down only when a considerable reduction of load occurs, when the damper regulator rises and closes a balanced valve in steam line.

Should the loads be such that the fans do not run as the speeds determined upon for the given load, and safety valves below boilers are stopped and when the number in use cannot maintain the pressure at the mentioned speed, another boiler is cut in. The stack temperatures under these conditions of operation seldom exceed 475-490 deg. F. (245.1 to 254.4 deg. C.) with mechanical draft and 625 deg. F. (329.4 deg. C.) with chimney draft.

RECEIVER.

Hunting Governors

THE ARTICLE, "Hunting Governors," by J. C. Hawkins, in the Feb. 15 issue, has attracted my attention, and while I consider all of the points brought out to be absolutely true, yet during my extensive experience with different types of automatic engines and governors of different types, I find that there are other causes that will lead an engineer to believe that the nonuniformity of speed of his engine is caused by a hunting governor even though he be quite certain that he has all parts of the governor properly adjusted and lubricated.

One instance I recall is that of a double eccentric Buckeye automatic engine whose cutoff eccentric strap and body had worn so that it was next to impossible to maintain a uniform lubrication, and as the engine was operated in a cement mill and subjected to all kinds of dust and dirt, the eccentric was found to get quite dry occasionally, causing a noticeable lagging and fluctuation in speed, especially when there was any attempt to use oil economically. But the very minute that a few additional drops of oil were put on, the engine would again return to normal steady speed; no fault of the governor.

Lubrication of the steam valves of an engine has much to do with the action of the governor. Sudden and extreme variations in load cause priming and pulling over of mud and slush, which wash the valves clean of all lubrication and result in serious vibration of all the valve mechanism, and although the governor will be doing all it can to steady things up, it cannot do so, though not in any way at fault. Proper, uniform and intelligent lubrication at all times of all parts of the engine helps greatly to uniform action of the governor as well as all other parts.

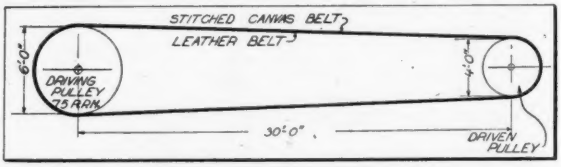
T. M. STERLING.

Strengthening a Belt Drive

I VISITED a power plant not long ago in which I found a rather unusual arrangement of belting—a heavy stitched canvas belt running over (riding) a 3-ply leather belt.

The leather belt is 24 in. wide, the canvas belt 18 in. wide, and the dimensions are about as indicated in the sketch herewith.

The engineer stated that he couldn't make the leather belt pull right—it slipped "to beat the band" and caused much trouble in the factory machinery to which it transmitted power. Thinking that the trouble was in the oldness of the belt he bought a new one, but it was no better than the first, and he couldn't use a wider belt on account of the limiting width of the pulleys. The principal reason why the belt slipped was that the pulleys ran very slowly in proportion to the stress in the belt and the load transmitted, the horsepower, amounting sometimes, to as high as 400.



LEATHER BELT REINFORCED WITH CANVAS

A belt expert was finally called in, and he solved the problem by laying a stitched canvas belt over the leather one, as I have already stated, drawing them both up tight, and treating the leather belt with a good dressing.

The principal objection to this method is the fact that there is bound to be some "creep" between the outer and inner belts that causes more wear than between the leather belt and pulleys, but that cannot be avoided. Besides, the plant is soon to be superseded by another in which pulley dimensions will be properly proportioned so that a single belt can be used without difficulty.

The reason why this drive did not slip years ago is that when first used the load was not nearly so large as at present. By this arrangement they are virtually carrying a double load with a single drive.

N. G. NEAR.

Rules for Packing Rods

I READ the article by A. D. Palmer in the April 1 issue, which is very interesting. But there is one thing many engineers and those in charge of machinery overlook, the directions for using the different brands of packing.

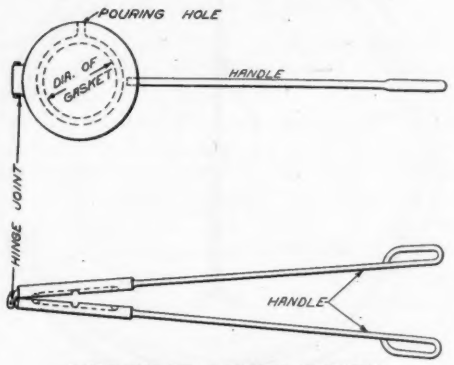
Packings are not made to give trouble, but the different brands and styles on the market are made with the view of obtaining the best results, and I believe this is every packing maker's aim; therefore be sure you are using a brand of packing which is best suited for each rod, stem and flange joints, then follow the directions which come with most packings, as it is my belief that most common packing troubles we have and hear of are due to not following instructions.

H. A. JAHNKE.

Simple Boiler Gasket Mold

SHOWN HEREWITH is the illustration of a single boiler gasket mold which at the present time is in use in the Liberty street power plant of the Central Ill. Light Co., of Peoria, Ill.

It consists of 2 round castings, each of which is about 7 in. in diameter and 1 in. in thickness, with lugs on one side so as to form a hinge joint. Opposite each lug a hole is drilled and tapped, into which is screwed a handle of ¾-in. iron rod formed as shown.



MOLD FOR LEAD BOILER GASKETS

A groove of the exact diameter but half the thickness of the gasket desired, is turned into the inner face of each disc.

In order to cast the mold, the faces of the disk are brought together and through the small hole shown at the top, the molten lead is poured. After a few moments' cooling, the mold is opened and a sharp clean gasket of lead is obtained.

By using this device, gaskets may be cast almost as quickly as the lead can be poured and in case the mold becomes too hot, all that is necessary is to dip it into cold water for a short time.

This mold was devised by C. A. Hoppin, consulting engineer, Peoria, Ill.

Abating Smoke

I AM ENGINEER at the Country Club Laundry and we burn Cherokee nut and Bonanza slack. It is hard to keep the steam up, so I burn ⅔ nut coal; it makes a big smoke and we have had so many complaints about the smoke we had to do something about it. I drilled a 9/16-in. hole over each door so a ¼-in. pipe would go through, then I connected with the steam pipe and let the pipe go through the wall about 3 in. Before I put in coal, I turn on the steam, and I find that the smoke disappeared.

My employer is proud of my experiment. This is a very good way to get rid of smoke. A. S. DILLON.

To Keep Oil Off Belts

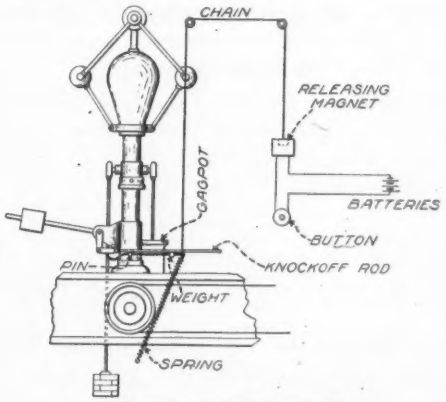
I HAVE CHARGE of a 6-ton belt-driven refrigerating machine. I had great difficulty keeping my belt from slipping, caused by the oil getting on the shaft and working from both ends to the tight and loose pulley, from there onto the belt, causing it to slip, rot and come to pieces. The following will explain how I relieved the trouble. The tight and loose pulleys were 30 in. in diameter. I made 2 round disks, 31 in. in diameter, of No. 16 gage iron, cut a hole in center 4 in. in diameter for crank shaft, then I split the disks in half and riveted a piece of iron of same gage 2 in. wide on one edge of one piece of each disk, allowing 1 in. to project over for lap when the disks were put around the shaft, using 6 3/16 by ½-in. screws to fasten the parts together.

Having gotten the disks around the shaft and bolted together, I drilled 6 3/16 by ½-in. holes through the disks into the rim of the wheels, tapped holes and put my screws through, using a leather washer between disks and wheels. After wrapping some tape around the shaft against the disks, the job was complete. I am glad to say that the trouble entirely disappeared. This arrangement allows a projection of ½ in. of disk over rim of pulleys. The centrifugal force throws the oil off.

W. M. SMITH.

Automatic Engine Stop

THIS STOP arrangement can be used on any Greene engine. There is a rod pivoted on the governor, underneath the knockoff rod, one end of the rod is curved, and comes up under the end of the knockoff rod, while on the other end of the rod is connected a spring at the bottom, and a chain at the top. The chain leads to a releasing magnet, which works from batteries, and can be used from any place in the factory.



STOP FOR GREENE ENGINE

When the electric button is pressed and the magnet released, the spring will pull the end of the rod down, and throw up the other end, lifting the knockoff rod, which will lower the toes and stop the engine. Any engineer will find this easy to make and it will be a big help in case of trouble. If the engine is running away, press the button and the engine will stop. W. N. L.

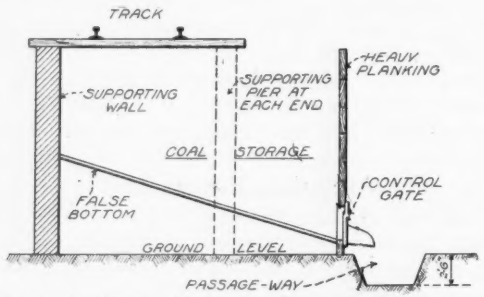
Reducing Coal Handling Costs

IN OUR PLANT the coal is delivered in cars run in on overhead trestle, from where it is dumped into the space below and then shoveled into barrows to be wheeled into the boiler room. Constantly increased requirements, however, made this method of handling more and more expensive, so that it became necessary to devise some method of eliminating this extra work.

As a result, instead of allowing the coal to drop to the ground, as heretofore, which necessitated re-shoveling, it was decided to construct a bin or hopper in which the coal would be stored and when needed be delivered to the barrows by gravity. This was accomplished by

building up a bin with walls on 4 sides and providing a false bottom which would tend to throw the coal toward a chute located in the front, where the outflow of coal was controlled by a simple gate arrangement.

In order to secure the greatest possible capacity, it was necessary to place the chute opening at the extreme bottom of the bin and then, to accommodate the barrows, so that the coal could be fed into them by gravity, an inclined passageway was dug in front of the chute, as shown in the accompanying sketch.



INCLINED BOTTOM OF COAL BIN INSTRUMENTAL IN CUTTING DOWN HANDLING EXPENSE

Even while now handling a greater quantity of coal, this arrangement has saved about 50 per cent as compared with the old shoveling method. M. SALLER.

A Poor Lubricant

ONE MORNING I was called to a stone-crushing plant to look at the engine, which was an Ames 10 by 12-in. slide valve with a Waters governor. The engineer at the plant was unable to start the engine. He told me that everything was just as he left it the night before. There was 90 lb. of steam on the boiler, and with the throttle wide open and the governor hooked up, the crank in the proper starting position, the engine refused to start.

After shutting the throttle and opening the cylinder cocks, the combined strength of 7 men on the flywheels failed to move the engine.

Having made repairs on this engine before, I was well acquainted with it, still I was puzzled for a while till I looked at the crosshead shoes. They were worn quite a little, so you could see daylight between the top shoe and the top guide. I tried to lift the crosshead up off the bottom guide, but it was stuck tight. I was obliged to take the top guide off and with a pick-handle pry the crosshead up off the bottom guide. There was plenty of oil on the guides, but there was also a hard substance that appeared to be baked to them, which had stuck the 2 surfaces together.

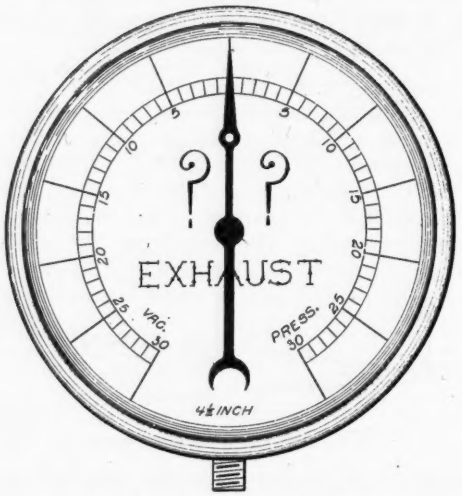
I asked the engineer if he had gotten the crosshead hot the day before, and he said, "No."

Something told me to smell of the guides, and when I did I noticed the smell of molasses; I knew in a minute what had happened. At this plant they use molasses as a belt dressing for canvas belts, and by some mistake the engineer got molasses on the crosshead in place of oil, and as there is a feed water heater in the frame of the engine, this is what caused the molasses to bake on so hard. After cleaning the crosshead and guides I opened the throttle and the engine started. M. MERRILL.

Incorrect Gage

ANOTHER GAGE was wanted on one of the condensers in a certain steam plant.

The oiler, finding an old pressure gage with the tube in it about right for the work, fixed it up, and when he had finished it, it looked like the sketch. He thought he had done a good job, but when he showed it



WHAT IS WRONG WITH THIS GAGE?

to the engineer he told him that he had made a mistake. The oiler was much puzzled for a few days, trying to find out what was the matter with his gage.

Can you tell what is wrong with it?

J. L. TOLMAN.

Peculiar Flywheel Wreck

A CURIOUS ACCIDENT occurred at a wagon factory in southern Indiana a few years ago. A large, heavy, slide-valve engine furnished the power for the entire factory and sawmill through the use of belts and line shafts. Many of the machines could not be thrown out of gear, so the engine always had to be started with considerable load. If the crank was not in the proper position for starting, the valve gear could be uncoupled and the engine worked back with steam to the right place.

In doing this one morning, the engineer opened the throttle too much, and the engine started backward rather quickly, and when he reversed it, bringing it to a sudden stop, the momentum of the heavy machines in the factory caused such a pull on the belt that the flywheel turned on the shaft, rolling the large key out of its seat, breaking the hub of the wheel into 3 pieces, and snapping off 2 spokes near the rim.

The wheel looked like a complete wreck, but was easily fixed by shrinking a heavy band on each side of the hub and putting on 6 turnbuckle stays from the hub to the rim.

After the job was completed, the machinist pronounced the wheel strong as ever, and so it proved to be, as it lasted several years or until a new Corliss was installed in place of the old slide valve engine.

C. M. KNOWLAND.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Fuel Waste in Ashes

YOUR EDITORIAL on page 145 of the Jan. 15, 1916, issue, entitled, "Fuel Waste in Ashes," follows a line of reasoning not quite clear to me.

In a plant with which I am familiar, an analysis of the contents of the boiler ash pits revealed 13.87 per cent combustible and 86.13 per cent ash, or, in other words, 13.87 lb. of combustible to each 86.13 lb. of ash. Analysis of the coal showed it to contain 9.3 per cent ash. In order to get 86.13 lb. of ash in the ash pit, 86.13 times 100, divided by 9.3, or 926 lb. of coal must have been burned. The original coal showed by analysis a percentage of 69.67 of fixed carbon; 13.87 lb. of combustible found in the ash pit would therefore represent 13.87 times 100, divided by 69.67, or 19.9 lb. of coal fired. The amount of coal then wasted into the ash pit would be in the ratio of 19.9 to 926, or 2.2 per cent. According to your editorial, the waste would be not 2.2 per cent, but 1.3 times 13.87, or 18.0 per cent. H. T. C.

A. Your trouble arises from the fact that you have confused your percentages. You take as your hypothesis an ash-pit analysis showing 86.13 per cent ash and 13.87 per cent combustible from coal containing 9.30 per cent ash.

This does not mean that 13.87 per cent of the coal combustible has escaped to the ash pit; for if all the combustible had been burned and only the ash constituent of the coal present in the ash pit, the ashes would have represented but 9.30 per cent of the coal as fired. The 13.87 per cent of the ash pit contents then represents but 1.50 per cent of the coal as fired (86.13 : 9.30 :: 13.87 : 1.50), which is an exceptionally good record of combustion. The approximate equivalent coal waste would then be 1.3 times 1.50, or 1.95 per cent. The waste would not actually be represented by such percentage, for the "loss factor" at such excellent combustion is not 1.3, but about 1.06. The actual equivalent coal waste would then be but 1.590 per cent (1.05 times 1.5).

These figures do not quite agree with your calculations, due to 2 reasons. In the first place, the formula is not absolutely correct, no such empirical formula can be; and secondly because you, in your calculations, have made questionable assumptions and overlooked certain other points.

You assume that the combustible in the ash is necessarily simply carbon and calculate the amount of coal which would contain 13.87 lb. of carbon, 19.9 lb. of coal. There is nothing to show that the combustible in the ashes is only carbon; it might contain any other combustible constituent of the coal. Accepting your assumption as correct, however, the burning of 19.9 lb. of coal would produce 1.85 lb. of ash, even if the coal was completely burned and no combustible from this particular lot escaped to the ash pit (another questionable assumption), so that the amount of ash upon which to figure the coal requisite would be 84.28 (86.13 minus 1.85), not 86.13, as you took; 906.24 lb. of coal would contain 84.13 lb. of ash, and this added to the 19.9 lb. required for 13.87 lb. of carbon totals to 926.24 lb. Of this amount, the 19.9 lb., or 2.15 per cent, are assumed to have been wasted. This is but slightly more than you would have arrived at if you had performed the much simpler calculation of 1.5 times 1.3—the rule advanced in the editorial.

As the coal must have contained a valuable volatile constituent, the 19.9 lb. fed to the grates could not all have been waste and the equivalent coal loss could not have been as great as 2.15 per cent. Disregarding the moisture in the coal, all of its constituents could be burned except that of ash, so that the weight of coal which would have been supplied for the 13.87 lb. of combustible in 100 lb. of ash might only be 15.3 lb.; 13.87 times 100, divided by 100 minus 9.30. This would contain 1.42 lb. of ash, leaving 84.71 lb. upon which to figure the effective coal consumption, which would be 910.75 lb. Adding this to the 15.3 lb. supplied for furnishing the combustible in the ashes gives 926.05 lb. Fifteen and three-tenths is 1.64 per cent of this total, and would measure the equivalent coal loss due to the presence of the combustible in the ash. This is the exact measure of loss or waste, if the moisture in the wasted coal is ignored and, this, even if considered, would have no appreciable effect on the result. The similarity between this exact figure and that of 1.59 per cent attained by the formula when using the correct factor is striking.

I might add that the plant you refer to is exceptionally efficient as far as burning its coal is concerned and that if the boiler efficiency is proportional to the grate efficiency, it must be an exceedingly efficient plant.

REGINALD TRAUTSCHOLD.

Operation of Arcing Ground Suppressor

COULD YOU explain to me the operation of an arcing ground suppressor as used on a 3-phase 60-cycle 13,200-v. line?

2. Also, please explain the operation of the Lincoln synchronizer. O. W.

ANSWERS

AN ARCING GROUND on an ungrounded system may be cleared by the arcing ground suppressor. When a ground occurs on any phase, that phase is temporarily doubly grounded by an oil switch operated by a selective relay. This second ground, acting as a shunt, lowers the voltage across the arc, which, therefore, ceases, and the switch opens (through a resistance to prevent oscillations). The ground is thus cleared.

In a cable system the grounded phase is permanently connected to ground, as otherwise the arc would immediately return when the switch opened, due to the short distance between core and sheath.

2. The Lincoln synchronizer, made by the Westinghouse Electric & Manufacturing Co., is a comparatively small machine of which the iron parts are similar to the field magnet and armature core of a small 2-pole direct-current motor, except that both field core and armature core are laminated.

The field magnet is excited by alternating current by connecting its winding to the bus bars. The armature is wound with 2 coils placed at right angles to one another and independently connected through collector rings and a suitable switch to the terminals of the incoming machine. One of these armature coils has connected in series with it a noninductive resistance, while the other has connected in series with it a large inductance. The armature of the synchronizer has attached to it a pointer which moves over a divided circle.

When the 2 machines are of like frequency this pointer is stationary and its reading on the circle indicates the phase difference between the 2 machines. When one machine runs at a slightly higher frequency than the other, the pointer rotates in a certain direction, indicating at each instant the changing phase difference between the 2 machines. When, however, one machine runs at a frequency slightly lower than the other, the pointer rotates in the opposite direction, indicating at each instant the changing phase difference between the 2 machines.

The speed of the pointer in revolutions per second is in each case equal to the difference in frequency between the 2 machines in cycles per second.

Of course, the arrangement may be so made that the dial is revolved and the pointer stands still, but this is not usual.

O. H. H.

Boiler Questions

WHAT IS the number of square feet of heating surface allowed in different types of boilers?

2. How many square feet of heating surface are there allowed to one square foot of grate surface?

3. What is the evaporating point of water?

4. How would you find the water level in a foaming boiler?

5. In case the throttle valve should become loose from the stem and prevent the steam from entering the valve chest, what would you do?

6. What clearance should a boiler have between the furnace wall and shell at fire line?

7. Why should a foaming boiler cause an explosion?

8. What size hole would it be safe to cut in an iron boiler 5/16-in. thick, without placing a flange around it?

9. When you open a boiler and look in, where does the scale lie thickest? What causes that?

10. Which are best, riveted flues or lap welded ones?

SUBSCRIBER.

ANSWERS

THE SQUARE FEET of heating surface allowed per horsepower varies from 10 to 12 ft. This differs more with the ideas of the makers of boilers than it does with the type of boiler, but perhaps an average value might be, for water-tube boilers, 10 sq. ft.; for tubular boilers, 12 sq. ft.

2. Usually there are from 30 to 35 sq. ft. of heating surface for each square foot of grate surface, but this amount will vary with the idea of the designer, the kind of coal to be used, and the amount of draft available.

3. The temperature at which water will evaporate depends on the pressure under which it is evaporated. At atmospheric pressure, the boiling point is 212 deg. F., and at 100 lb. gage pressure, it is 338 deg. Other values would be obtained from a table of the properties of saturated steam.

4. In a boiler which is foaming badly it is a difficult proposition to get the water level with any accuracy. Probably the best way to get at it is to throttle down the valves in the connections to the water column, so as to eliminate the surging as much as possible, then blow down the water column and the gage glass, and as the water comes back in, it will indicate about the right level.

5. When the disc of a throttle valve comes loose from the stem, if, as is usually the case, the steam flows to close the disc, there is not much to do but shut down and repair the damage. There is no way of getting that disc to stay off the seat except as the stem holds it off. Of course, if the disc cannot be made to go back on to the stem, temporary operation might be possible by reversing the connection of the throttle valve so that the steam flows to open the disc, but after you have the valve off, it is usually quite as easy, and much more satisfactory, to make a good job of it and repair the whole thing.

6. Clearance between the boiler shell and furnace wall depends on the size of the shell. For shells up to 32 in. diameter, 2 in. clearance is allowed; from 36 to 48 in., 3 in. clearance; from 54 to 72 in., 4 in. clearance.

7. There is no reason why a foaming boiler would cause an explosion, unless the foaming is so bad that the water lifts from the shell plates and allows these to become overheated and, therefore, weakened. Foaming is usually caused by an excessive amount of small particles of solid matter in the boiler, and this may be due to the accumulation of a large amount of loose scale in the boiler which, if it settles over the furnace, may result in overheating of the plates, and thus weakening them so that they will give way.

8. While there is no definite statement in the Ohio rules as to the size opening which can be cut in a 5/16-in. plate, the minimum number of threads permitted in a screwed connection to the boiler shell is 4. With standard size pipe, this would mean that the ¾-in. pipe, carrying 15 threads to the inch, would have in a length of 5/16 in., a little over 4 threads, and this would, therefore, be the largest size connection which could be made into the shell without reinforcement.

9. The place where scale will lie thickest in a boiler depends on the type of the boiler, care it has had, and the circulation. Usually, however, the use of the blowoff at the back end will keep the back plates fairly clear of scale, and the rapid circulation over the fire will keep these plates reasonably clear. The intermediate point, a little back of the bridge wall, will usually, therefore, be the place where the greatest accumulation will be found.

10. Whether riveted or lap welded flues are better depends on the size of the flue. For small sizes, it is difficult to roll up the plate and make a tight riveted joint without straining the plate at the edges, and for

these smaller sizes, the lap welded joint will be amply strong. In the larger size, there is some difficulty in making a lap welded joint, and there is always some uncertainty as to the strength of this joint, so that the riveted joint is more satisfactory. A. L. R.

Induction and Synchronous Motor Problems

IF YOU desire to run an induction motor as a generator, how much would you have to increase its speed to carry full load? Will it carry its full rated load without trouble?

2. How will the voltage and the power factor be affected?

3. Will any changes in the connections of the recording wattmeter be necessary?

4. In changing over an alternator to operate as a synchronous condenser, the recording wattmeter ran forward and the higher the degree of excitation the greater was the speed of the meter. Did the meter in this case register the actual number of watts which the synchronous condenser was using or was the current merely passing through the machine without doing any work? Does it mean that the stations had to supply the extra power the meter showed? The synchronous condenser was not connected with anything else.

5. What is the formula for determining the current used in 2-phase motors, the power factor being unity?

L. L. P.

ANSWERS

IN ORDER for an induction motor to "feed back" full load into the line, it must run approximately as much above synchronism as it ran below synchronous speed under full load as a motor. That is, if a motor "slips" 2 per cent on full load as a motor, it will have to run about 2 per cent above synchronism to generate full load. The motor will carry full load without trouble.

2. The voltage will tend to rise, depending on the percentage of overspeed, the action being similar to that of a shunt-wound generator when it is "speeded up." If regulators connected to other generators hold the bus voltage constant, the induction generator will merely assume a greater portion of their load current.

Although the induction generator sends current into the feeders, it still must depend for its magnetizing current on the other generators so that it is always a more or less inefficient device. The actual power factor varies with a great many factors, but is approximately for any load the same when generating as when motoring.

3. If the recording wattmeter indicates forward when the machine is motoring, it will run backward when generating. If it is desired to read directly the wattage output as a generator, it will be necessary to change the meter connections.

4. You say that the wattmeter (more correctly watthour meter) ran the same direction when the alternator was running as a synchronous condenser as it did when generating. This would not be the case unless the wattmeter connections are incorrect. The synchronous condenser is actually absorbing energy from the other generators and would consequently indicate an "input" of power.

A synchronous condenser supplies magnetizing current to other synchronous or non-synchronous machinery, but its internal losses—copper and iron—must be supplied to it electrically. The more excitation one applies, the greater become the losses and naturally the wattmeter would run faster. It must be remembered, however, that the meter does not integrate the wattless current delivered to the buses, but only the actual working kilowatts. This amount of energy was in this particular instance supplied by the interconnected stations.

5. For a balanced 4-wire, 2-phase system (one in which the phases are independent), the number of kilowatts are obtained by dividing the product of 2 times the number of volts across either phase times the number of amperes in any line, divided by 1000. The number of amperes of current flowing are then equal to the product of 1000 times the number of kilowatts, divided by the product of 2 times the number of volts.

If a 3-wire 2-phase system is used, the common or center wire will not carry twice the current in the outside wires but only $\sqrt{2}$ times as much. That is, if the outside wires are carrying 10 amp., the middle or common wire will carry 14.1. V. E. JOHNSON.

Proper Vacuum for Heating System

HOW MUCH vacuum would you carry on the Warren Webster system, and how much back pressure; and would you carry the same vacuum in summer as in winter? SUBSCRIBER.

A. The vacuum carried on the Webster system depends on the size of the system and the back pressure desired on the engine. There must be sufficient difference in pressure between the exhaust pipe of the engine and the end of the returns to keep the radiators clear of water and air. On the end of each radiator is an automatic vacuum valve which closes as soon as steam enters it, so that no steam is pulled through the radiators by the vacuum. A common practice is to carry from zero to 5 lb. back pressure on the engines, and to carry a matter of 10 in. vacuum at the end of the returns, although, as already stated, this depends entirely on the size of the system and the length of the returns.

In summer, practically no heat will be used for the heating system, and the vacuum pump is usually shut down and the steam exhausted to atmosphere. If some heating is required, the atmospheric exhaust valve can be set for one pound back pressure and sufficient vacuum carried on the returns to keep the heating coils in use, clear of air and water. This vacuum will be less than that required in winter. A. L. R.

Load Factor

WHAT IS station load factor? W. J. N.

A. The Standardization Rules of the American Institute of Electrical Engineers define the load factor of a machine, plant or system as the ratio of the average power to the maximum power during a certain period of time, such as a day, month, or a year. The maximum is taken over a short interval of the maximum load within that period.

In each case the interval of maximum load and the period over which the average is taken should be definitely specified. The proper interval and period are usually dependent upon local conditions and upon the purpose for which the load factor is to be used.

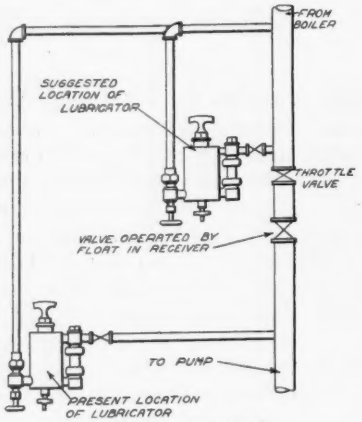
O. H. H.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Proper Lubricator Connections

A FEW DAYS AGO, I dropped in to see an engineer friend of mine, and while I was there he asked me if I understood the sight-feed lubricator. I replied that I did. He then asked me to look at the one on his feed pump, which he said would work a short time after



WHICH IS RIGHT?

starting the pump and then it would feed by spells. He told me it was installed about 10 years ago and gave trouble from the start.

You will see from the sketch how the lubricator was piped, also how I think it should be piped to operate correctly.

I would like to hear through Practical Engineer what other readers say in regard to it. M. M.

What Caused Bent Stay Rods?

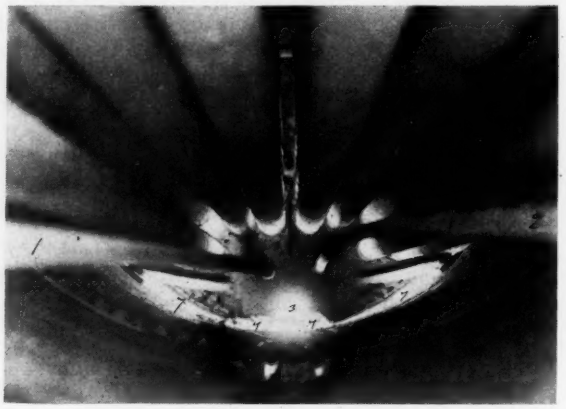
I WISH to have the opinion of readers as to what caused the bent condition of the stay rods, as you will notice by the photograph, the one to the right is bent up out of a straight line about 5 in. The one to the left side is bent out to the right about the same radius of curve. The one to the right is curved upwards.

The boiler has been in use for about 12 yr., and is the third or No. 3 boiler operated with 2 others and which has been cleaned and washed out each and every 2 weeks. It was cleaned and gone through on Feb. 20, and everything was O. K., as usual. On March 5, we opened up the boiler to clean and found the stays buckled as shown by the photograph.

We have been carrying 75 to 90 lb. of steam pressure on these boilers at all times. There had not been any repairs on the boiler previous to finding it in the above condition. I loosened up inner nuts and the stays came back down and it took ⅜-in. washer on the outside to take up what they relaxed. When this occurred, the girth seam showed a slight leak, as shown in the photograph, which is over the bridge wall.

I would be pleased to hear from readers the cause of the stays bending upwards and the direct cause for so much expansion.

Any questions you wish to know further, I will be pleased to answer.



INTERIOR VIEW OF BOILER

The boiler is rated at 85 hp., length of boiler is 18 ft. Referring to the cut: 1 is a staybolt bent to the right; 2, staybolt bent upwards; 3, electric light; 4, sediment to hold light; 5, seam that leaked; 6, water; 7, sediment. R. C. W.

Cleaning Injector

ON PAGE 229 of the Feb. 15 issue, a subscriber asks how to clean the tubes of an injector effectively.

We offer in reply the method we have found effective in our factory. We first take the injectors apart, then dip all parts in a solution of muriatic acid, 1 part acid to 7 parts water, leaving in the acid long enough for the boiling action to stop, when we wash them thoroughly in cold water to stop action of acid on the metal and rinse in hot water to remove dead acid. Next, we dip them quickly into a mixture of 2 parts sulphuric acid and 1 of nitric acid to brighten and wash off in cold and then hot water.

This method thoroughly cleans and brightens, but where the injector is very greasy, it should first be washed in hot potash water to remove the grease, then given the acid baths. Files and scrapers should never be used to clean injector tubes because the injury that is almost certain to be done the tubes by this method of cleaning will surely put them out of commission.

L. A. PURSELL.

Effort of Changing Polarity

IN THE plant I am running we have 1 2800-v. a.c. generator and 1 250-v. d.c. generator. The a.c. generator is running a substation 2½ miles away, running another 250-v. generator.

The polarity was accidentally changed on one machine and the other machine was changed to it, as we use the track as part of the negative line for both d.c. machines, and both d.c. machines are coupled together. How and why did it work with practically no difference only in the meters, which read backwards?

F. H. JOHNSON, J. H. HUTTON.

Stopping Compound Engine

IN ANSWER to C. N., page 355, April 1 issue, the cranks on cross-compound engines are usually set at 90 deg., so one is always off the center.

We will assume that all the load except the friction load is off when shutting down. First, close the throttle valve, then disconnect the condenser from the engine by opening the atmospheric valve, or, if you have an air-bleeder, open that and let air into the condenser, so as to destroy the vacuum. By this time the engine has slowed down considerably. Now hang up the hook rod, put in the bar, and watch the engine; you will have to use your own judgment as to where the engine will stop.

Loosen up the throttle valve so that you are sure to get it open in a hurry, if needed. Keep your right hand on the bar and your left on the throttle, and watch the high-pressure crank. Of course you have put the pin or collar under the governor. Now, as the engine is ready to stop and on its last stroke, move the wristplate by the bar so as to admit steam on the wrong side of the piston. Of course there are times when you have to push the crank around once or twice before you are able to stop the engine where you want it.

It is always a good idea to stop any engine near the head center.

CHARLES MAGNUS.

FOR THE information of C. N., who inquires the best way to stop a compound engine with direct-connected air pump, on page 355 of the April 1 issue, I will say that when stopping engines provided with this style of air pump, it is preferable to close gradually the throttle and injection valve together as the engine slows down, closing the throttle some 2 or 3 revolutions before the injection valve is shut, so that the steam in the cylinders and passages may be condensed and thus the valves in the condenser saved from the injurious effects of the heat of the steam. The injection valve should be shut at about the last revolution of the flywheel, which will leave the valves covered with water and protected to some extent against leakage of steam.

Some of the older designs of engines, of which the Corliss, built by The Geo. H. Corliss Steam Engine Co., is an example, made no provision for disconnecting the valve gear from the eccentric and moving the valves by the starting bar.

In such cases, all one can do is to handle the engine by the throttle, using judgment as to when to shut off steam and have the engine drift, stopping in the desired position.

When the valve gear is so designed that it can be moved with the bar, it is usual to disconnect the hook rod some 4 or 5 revolutions before it is thought the engine will stop, insert the bar in its socket, bring the valve gear to its central position, and when the wheel is on its last revolution, to block the progress of the high-pressure pistons either by closing the exhaust valve at the end of the cylinder toward which the piston is moving or by the admission of steam to that end of the cylinder.

When, due to conditions, the engineer cannot see the crank or connecting rod, a study of the relative position of the rocker arm and crank when in motion, will enable the engineer to stop the crank in the desired position by watching the rocker arm when working the engine with the starting bar.

In cross-compound engines, a bypass valve is usually provided which allows high-pressure steam to be admitted to the low pressure cylinder at a reduced pressure, to enable the engine to start from rest with the low-pressure side should the high-pressure crank be on the dead center, so that generally the position of the high pressure crank is ignored when stopping.

RECEIVER.

Polarity Indicator

ANSWERING THE INQUIRY of J. W. as to homemade polarity indicator, I would suggest the following: A solution of iodide of potassium with a little starch added and sealed in a glass tube and terminals provided by which a current can be passed through the polarity of the circuit can easily be determined as iodine is liberated by the current at the positive terminal and turns the starch blue around this terminal. Instead of iodide of potassium, phenolphthalein may be used. There are several polarity indicators on the market which are inexpensive. There is also polarity paper on the market which I use and which can be obtained by any supply store and which the manufacturers of mercurial vacuum lamps supply without charge. Wet a small piece of the paper and touch the paper with the conductors, making sure that the conductors will not come in contact with each other. The negative terminal in this case will turn the paper around the conductor pink.

CHAS. BEHOUNEK.

IN MARCH 1 issue, J. W. asks how to make a polarity indicator. Here are some of the polarity indicators I have used when I did not have an instrument. Blotting paper moistened with a solution of iodide of potassium in water and the 2 terminals touched to the paper will give a brown spot at the positive terminal.

Adding starch water to the iodide solution will give a blue spot at the positive terminal.

Another method is to wet a piece of blueprint paper and use the same way. The *negative* terminal will bleach the print white.

A raw potato in the circuit will boil at the negative terminal. A cheap pocket voltmeter or ammeter will indicate the + and — terminals by the movement of the pointer. If it is used on higher voltage than the instrument is calibrated for, a resistance can be put in series.

R. L. MOSSMAN.

PRACTICAL
ENGINEER
Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED THE FIRST AND FIFTEENTH OF EACH MONTH
BY THE TECHNICAL PUBLISHING CO.
537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1916, by Technical Publishing Co.
Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 22,500.

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Meeting the Central Station Man Squarely

To be worthy of his profession, the engineer must be a truth-seeker from beginning to end. In the long run, he builds his reputation upon his loyalty to facts, regardless of where they may lead. Discerning employers appreciate this more than many an engineer believes, and respect his willingness to co-operate with the central station man when the latter seeks permission to make a power "survey" of the plant in hopes of getting the owner to buy electricity from the local company.

It takes some grace to join in a study of this kind, knowing that one's job may be involved. But the dog-in- the-manger attitude is out of date now, and the engineer only hurts himself who purposely puts stumbling blocks in the way of an adequate investigation of his installation. Petty obstructions react upon the man who tries to utilize them to his own benefit. Helping the central station power engineer in his analysis by no means need imply that the operating engineer agrees with him in his deductions. As a matter of fact, it often affords an opportunity to learn how to increase the efficiency of the station along lines which will make the continuance of independent power generation the only justifiable policy. How much better it is to meet the central station man in a friendly way, to show him everything about the station and its running methods, and to get on good enough terms with him to enjoy the benefits of his outside criticisms and suggestions, if he lets these fall, than to sulk in the boiler room while the man from the local lighting company is in the engine room, and vice versa!

The days are about over when a mere assertion that a change in plant policy is the only proper solution of the local problem, is going to be sufficient to put the owner's name upon the coveted power contract. It is only natural that central station men should emphasize the power of example in dealing with busy plant owners; but because the A. & B. Tool Company has found purchased power the more economical means little or nothing to a proper solution of the problem in Brown's Worsted Mills. The tool company may be the biggest concern on the salt-water side of Oshkosh, in its own line, it very likely pays the heaviest taxes in town; its manager and superintendent doubtless play golf twice a week with Brown, and their opinions unquestionably carry a lot of weight with him—BUT, all this contributes mighty little to the solution of Brown's specific power problem. Wasting sleep over the intimacies of the "Big Boss" with the central station manager and some of the latter's customers is a poor policy indeed, unless the time taken from bed is put to account in making the sharpest kind of a study of the local plant economics and the lessons thereof.

No! The way to handle the advent of the central station man is to assist him in all reasonable inquiries without assuming any responsibility for his work; to urge him to point out the weak spots of one's layout, so that their improvement may be considered; and finally, to study the larger problem of station service in a way that will admit of no halfway measures when the issue is put up to the owner. Never permit the central station man to overlook fixed charges, when he presents his conclusions; or rather, if he does overlook them, whether pur-

posely or otherwise, find out what is their bearing on the problem and be prepared to produce the figures in the Big Boss' presence.

Here, for instance, is a plant where the local central station staff figure, let us say, a saving of two or three hundred dollars a year by the use of their service. Not a word is said in the report about interest, depreciation, insurance and taxes on the equipment required, and because the plant is small, or because of something else, detailed estimates of the saving in boiler and engine room labor and of the fuel economies anticipated are omitted from the proposition sent to the plant owner. Now, this may be a case where power should be purchased; but until all the evidence is in, with full particulars as to the assumptions made, the engineer can face the situation calmly. As we have said so often, the burden of proof is upon the organization seeking to change the plant policy, and the more the operating engineer studies power economics, the surer he can be that the maintenance of his installation as a useful part of the owner's organization will depend upon the efficiency of himself and his staff in no small part and upon the real facts of the case, rather than upon superficial judgments as to the expediency of going elsewhere for power.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.

required by the Act of Congress of August 24, 1912, of Practical Engineer, published Semi-Monthly at Chicago, Ill., for April 1, 1916.

State of Illinois)
County of Cook)
ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Chas. Sanford Clarke, who, having been duly sworn according to law, deposes and says that he is the Secretary of the Practical Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Name of— Post-Office Address—
Publisher, Technical Publishing Co., 537 S. Dearborn St.
Editor, Arthur L. Rice, 537 S. Dearborn St.
Managing Editor, Arthur L. Rice, 537 S. Dearborn St.
Business Manager, E. R. Shaw, 537 S. Dearborn St.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.)
E. R. Shaw, 537 S. Dearborn St.
Arthur L. Rice, 537 S. Dearborn St.
Chas. S. Clarke, 537 S. Dearborn St.
C. B. Leech, 1472 W. Clifton Blvd., Cleveland, Ohio.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other persons, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is.....

(This information is required from daily publications only.) Chas. Sanford Clarke, Sec'y.

Sworn to and subscribed before me this 24th day of March, 1916. Warren A. Lathrop, Notary Public.
[Seal.] (My commission expires October, 1918.)

NOTE.—This statement must be made in duplicate and both copies delivered by the publisher to the postmaster, who shall send one copy to the Third Assistant Postmaster General (Division of Classification), Washington, D. C., and retain the other in the files of the post office. The publisher must publish a copy of this statement in the second issue printed next after its filing.

AMONG THE various Bureaus of the government, perhaps that of Mines touches most closely the power-plant field, since it deals largely with production and utilization of fuels. Its work has to do primarily with working of mines to secure efficiency and safety, mapping out possible development, and securing effective use of product. Prominent among its accomplishments of the last year are the giving to the public of processes devised by Dr. Walter F. Rittman, for refining petroleum so that 200 per cent more gasoline may be obtained than formerly; for producing benzol and toluol from petroleum—the first a base for the manufacture of dyes, and the second for the manufacture of high explosives—thus pointing the way to independence of the United States from all other countries in these 2 important lines of industry.

Safety training and methods has reduced the death rate among miners from 3.49 per 1000 in 1914 to 3.16 per 1000 in 1915, and rescue methods have resulted in saving 200 men from mines after disaster.

Investigation of fuel burning has given a basis for improvement of methods in heating public buildings, and in power-plant furnaces and boilers; with resulting reduction of smoke from power plants and smelters.

In the petroleum industry, preventable waste was pointed out amounting to $50,000,000 a year, $10,000,000 being in one state, and methods were sought in co-operation with state officials and private organizations to reduce this waste when drilling and working wells.

A. S. M. E. at the Crescent City

SPRING MEETING AT NEW ORLEANS, APRIL 11 TO 14

IT would be impossible to express in mere words the pleasurable remembrance of those who were fortunate enough to enjoy the hospitality of Birmingham, Ala., and New Orleans, La., during the week of April 10 to 15. In Birmingham, a day crowded with sights of the wonder work of a few years in transforming a stretch of farm lands into a great mining and industrial center. In New Orleans, the balance of the week filled with the romance of the City of Carnivals, the glamor of Southern skies and flowers and the achievement of man's skill and determination in overcoming seemingly unsurmountable natural obstacles and creating a healthful, beautiful city and fertile lands, where the river and lake formerly held undisputed sway. Two more excellent illustrations of the work of engineers in subduing the forces of nature for the benefit of man would be hard to find.

At Birmingham, the day was devoted to trips to the great mines, furnaces, mills and plants of the Tennessee Coal, Iron and Railroad Co., and the American Steel and Wire Co., every provision being made by the committee of the Local Section of the A. S. M. E. for the comfort and convenience of guests, that they might get an insight into the big developments of Birmingham. The immensity and orderly neatness of the plants, and the tremendous possibilties for even greater developments left no doubt that this is to be the "Pittsburgh of the Southland."

Proverbial southern hospitality was never better exemplified than in the ceaseless effort at New Orleans to leave no wish of any visitor unfulfilled and even to suggest many activities and pleasures of which the stranger would not have dreamed. It would be impossible to give even a slight idea of the trips in large and small parties, and the individual courtesies which will long be remembered by grateful recipients of those favors, and the resume of the technical meetings must suffice.

These meetings were held in the forenoons, afternoons and evenings being devoted to inspection trips and social events. The inspection trips covered the harbor improvements and cotton warehouse reclaimed lands and pumping plants, water works, sewerage and drainage systems, power plants for railways and lighting, refineries for sugar and oil, lumber mills, creosoting plants and refrigerating plants. Social events included a reception on Tuesday evening, an address by the Commissioner of Public Works of New Orleans, W. B. Thompson, on Wednesday evening, and a dance on Thursday evening.

ORGANIZING FOR PREPAREDNESS

OF THE technical sessions, that of Wednesday morning was devoted to Industrial Preparedness for Defense; Thursday morning to engineering development specially connected with New Orleans and Louisiana industries and Friday morning to the measurement of flow of fluids and to miscellaneous papers.

The general plan for the first steps toward Industrial Preparedness as given in the paper by Spencer Miller was outlined in the issue of Practical Engineer for April 15, p. 377, his paper covering somewhat more in detail the details of information to be gathered, and the lines of industrial activity which should be made complete to give adequate facilities for meeting defense requirements.

Discussion called attention to the need of preparation for defense in industries other than arms and ammunition manufacture, such as uniforms, shoes, medical supplies, nursing, transportation and training of officers. It was pointed out that it takes three men at home to maintain one man at the front and provision to make the work of those three men effective is as much a part of preparedness for defense as is the raising and training of an adequate army.

MULTIPLE EFFECT EVAPORATORS

ON THIS subject, E. W. Kerr presented a paper Thursday morning, describing the action of such evaporators and analyzing the factors on which capacity and efficiency depend. Evaporators are somewhat similar in action to surface condensers but have to work with steam at pressure varying from 5 lb. gage to 15 in. vacuum. In the condenser, fouling of the surfaces is mainly on the steam side due to oil, but in evaporators the fouling is on the liquor side, and there are many incondensible gases other than air, such as ammonia and sulphur fumes, to be dealt with. It is, therefore, important to avoid "air pockets" where such gases might gather. Scale may be removed from the steam side of tubes by filling with molasses during the dull season, the acid of molasses tending to cut the scale. On the liquor sides of tubes the scale may be removed by filling the liquor compartment with a solution of soda or hydrochloric acid, and boiling. Mechanical means of "cracking" off scale, is also possible, but may be detrimental if not done intelligently.

Analysis was made of other factors such as rapid circulation, height of juice in the evaporator, temperature difference between steam and juice and density of liquor being boiled. Details of different types of evaporators were illustrated and described and results of tests given. A curve to average results from all tests made on four types shows the coefficient of heat transmission or heat per square foot of surface per degree temperature difference per hour to be less as the pressure decreases, being 560 B. t. u. at 7 lb. gage, 540 at 5 lb., 505 B. t. u. at 3 lb., 465 at 1 lb., 430 at 0, 375 at 5 in. vacuum, 290 at 10 in., 180 at 15 in., and 50 at 20 in. The variation was great, however, and was for different types, so that these average values are only useful as approximations.

In the discussion it was pointed out that in this as in most investigation, overall tests, while useful, do not give data by which design can be improved. Effect of variation of each detail must be studied so that the designer can tell how change in any detail will affect the operation of the evaporator or other device.

The paper of Professor W. B. Gregory on Low Lift Pumping Plants gave the history of their development, described the pumps used and gave arrangement of plants and results of tests. An abstract will be published later.

Mechanical Equipment used in the Port of New Orleans, by William von Phul, showed the use of conveyors, elevators, telphers, trucks, coal handling equipment, cranes, car ferries and floating derricks. In all cases the effort is to use mechanical handling of freight where the work is of such nature that it can be done, usually where large quantities of one kind of goods are to be handled repeatedly. Discussion brought out that in deciding whether to use mechanical handling or not, it was necessary to consider whether the equipment fitted the conditions, as, for instance, a tractor and trailer system might, because of the long turning radius, require so much hand carrying in loading from and unloading into storage piles as to make the extra cost of all direct operating trucks an economy.

Measuring Flow of Fluids

For natural gas measurement, where large quantities must be measured at widely different and pulsating pressures and varying temperatures, Francis P. Fisher showed that the means heretofore used have been unsatisfactory.

Wet meters such as are used by artificial gas companies are unsuitable because of first cost and care required. For a clean, pure, perfect gas, the proportional meter, which divides the gas between a large and a small channel whose ratio is known and measures the smaller volume would be satisfactory, and fairly good results have been obtained. The presence of dust, water, salt, oil and gasoline, and accumulation of hoar frost in winter call for constant attention to keep these meters in order, and there are few men competent to do the work.

Pitot tube measurement, especially in standardized tubes of polished brass will, when at their best, give very close results, but care must be taken to set the orifices at a point which has the average velocity pressure, as this varies greatly from side to side of the pipe.

As a result of numerous sets of experiments, determination of constants for orifices have been made, using a displacement method with carefully overhauled compressors as meters and careful tests to determine leakage allowance, and the results have been embodied in a curve of velocity coefficients to be used with orifice meters. The computation of flow is somewhat complex, but is easily cared for by a special slide rule.

Of interest in this connection is the paper on Deviation of Natural Gas from Boyle's Law, by R. F. Earhart and S. S. Wyer. This showed by results of tests that natural gas has marked variations from the law that pv is constant for a given temperature, and these variations are all in favor of the buying company when measurement is made at high pressure and payment is made on the basis of cubic feet at atmospheric pressure. Different gases have different deviations, but there is no relation between the deviations and the ethane content. For this reason the use of Boyle's Law in measuring problems on high-pressure natural gas gives only rough approximation.

Results of experiments were shown in curves and Professor P. F. Walker questioned the accuracy of some of these on account of their disagreement with earlier tests and divergence from tests made at the University of Kansas.

Experiments on Water Flow through Pipe Orifices by Professor Horace Judd, showed that orifice diaphragms can be used very satisfactorily with reliable coefficients for measuring flow. Details and tables will be published later.

In the miscellaneous papers of Friday's session, N. W. Akinoff described a new machine for testing running balance of revolving parts and determining where and how much weight to apply to correct any unbalancing. A New Form of Viscosimeter was described by H. C. Hayes and G. W. Lewis, but in the discussion the advisibility of the friction method of testing was questioned, also the desirability of any form of test which introduced a new scale of viscosity when so many scales already existed.

Tests on Transmission of Heat in Boilers were presented by E. R. Hedrick and E. A. Fessenden. A new theory of the action of heat transmission was presented, a comparatively simple equation derived and the computations by this equation checked with results of experiments, a close agreement being obtained. The treatment is distinctly mathematical, and the usefulness of the equation yet to be proved.

To further the availability of resources and men in case of emergency, a group of prominent engineers and contractors of Chicago and vicinity have united in forming a Joint Committee on Military Engineering. These founder members are also members of the leading engineering organizations of Chicago, including local branches of the national engineering societies.

The purposes of the organization are to further military preparedness among engineers and their associations by the following means: Courses of lectures, assigned reading, studies and practical instruction in military engineering, assisting engineers to qualify as officers in the National Reserve Corps of Civilian Engineers, urging enlistment in engineer troops of the National Guard, furthering instruction in military engineering, in training camps, and other means which may, from time to time, seem advisable.

The program as already prepared by the Joint Committee, covering the points outlined above, extends from April 20 to July 25, a meeting being held each week, including lectures by Lieutenant-Colonel W. B. Judson, by Major P. S. Bond and by Lieutenant-Colonel M. M. Patrick, all of the U. S. Army Engineering Corps, and at other meetings, exhibition drills, inspection trips and exercises under the direction and guidance of officers of the engineer troops of the Illinois National Guard.

All engineers, contractors and their associates in the Chicago district are invited to join. Correspondence may be addressed to the Secretary, Robt. F. Hall, 111 W. Washington St., Chicago. This offers a good opportunity for those who believe in furthering the cause of preparedness for defense, and the need may arise, to co-operate and put the engineering ability of Chicago and vicinity into definite form for such service as may be required.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Boiler Feeder and Pumping Trap

IN the Farnsworth Duplex Boiler Feeder are 2 chambers, one of which is always open receiving condensation, while the other is under pressure feeding water into the boiler. Alternate filling and discharging of these chambers continuously drains the system and feeds condensation into the boiler giving double capacity, and assurance that the system is always free of condensation. This alternate filling and discharging gives absolute control of the Everlasting blowoff valves, which are the only working parts.

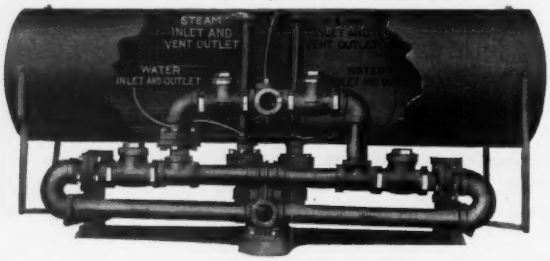


FIG. 1. SIDE VIEW OF FARNSWORTH BOILER FEEDER SHOWING WATER INLET AND OUTLET

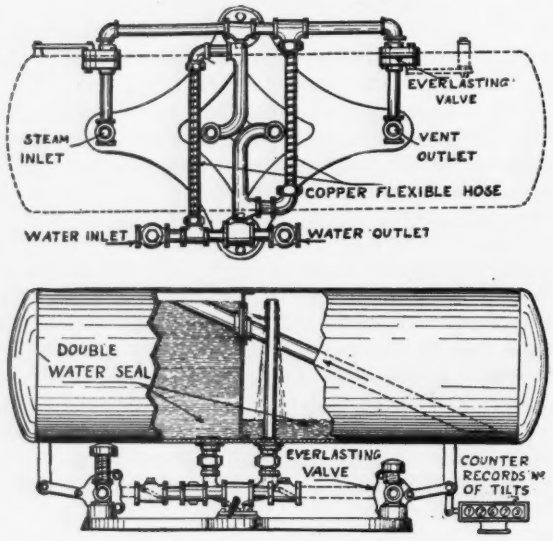


FIG. 2. PLAN OF BASE OF FARNSWORTH PUMPING TRAP WITH CONNECTIONS SHOWN

When the chamber which is receiving the condensed water is filled, the tank tilts on a knife edge trunnion, which operation automatically opens the valve in the outlet line and allows the water to discharge into the boiler. At the instant this outlet valve opens, the inlet valve at the entrance to the other chamber is opened and the condensation flow is diverted to that chamber.

Advantages of the Duplex Boiler Feeder are claimed to be: Ability to handle water at high temperature; low steam consumption; no lubricating oils or packing needed; sets on top of the boiler, therefore requires no floor space and but little piping. It acts as a receiving tank as well, requires no governor, is automatic and operates only when water flows into it.

The Farnsworth Pumping Trap collects condensation at low pressure and pumps it to any point of use or to any height by the attachment of a high-pressure steam connection, its method of operation being similar to that of the Duplex Boiler Feeder. It is provided with a recording counter, which makes it a metering trap.

The Farnsworth Mfg. Co., 65 Beverly St., Boston, Mass., builds this boiler feeder and the pumping trap.

Lubricating a Morgan Belt Drive

WHAT is probably the most interesting, though not the most difficult problem in lubrication recently presented to the Engineering Department of the Keystone Lubricating Co. was a Morgan Belt Drive in the plant of one of the larger steel companies.

As all may not be familiar with the Morgan Belt Drive, a brief description will not be amiss. In this case the Morgan Belt Drive is used to drive the wire rolls and is operated by 4 belts, each belt passing over an idler and 2 pulleys. Each pulley shaft has a gear wheel on the end, which drives two pinions, each pinion driving separate roll sets. The speed of the shafts ranges from 638.5 to 800 ft. per min.

The belts used are triple leather, one 48 in. and the others 34 in. wide, running one on top of the other, over the flywheel.

Lubrication of this machine was originally accomplished by a circulating oiling system, 2 jets of oil under pressure running into the bearings, which are chain oil type, and the problem was a composite one of reducing the friction load and, what was of greater importance, saving the belts from premature destruction from oil, which dripped and spattered from every bearing. Preservation of the belts was a material factor because each belt is costly, and play in the bearings actually pumped oil out of them profusely.

After some preliminary testing to determine the exact working conditions at various times, it was decided to discontinue entirely lubrication with oil and to install No. 6 Density Keystone Grease in the reservoir of each bearing. This having been done, the shafts were care-

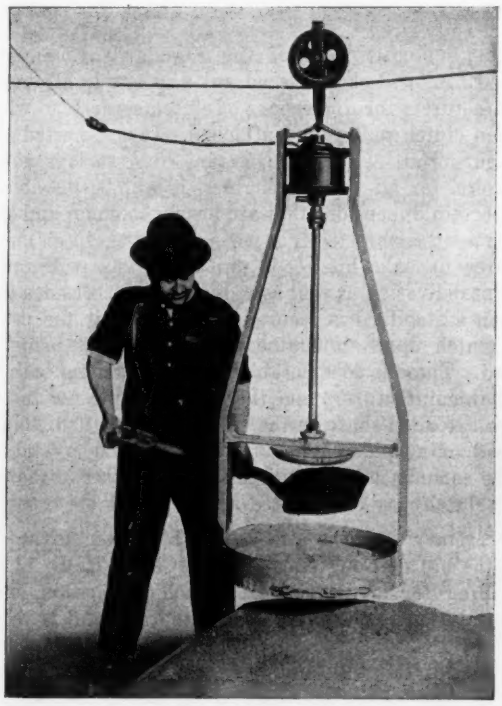
fully wiped dry and were then whitened to determine whether leakage and consequent flying lubricant had been eliminated.

Results are more than satisfactory in every respect, as no leakage shows at any bearing, and the friction load is apparently reduced materially, though this factor was not definitely recorded.

Gyratory Foundry Riddle

COST of labor is the largest item in the making of castings, and the device described herewith materially reduces this cost. It is a new and unique foundry riddle, of the gyratory type. The motion of the riddle is obtained by the inertia effect of an unbalanced flywheel which causes every part to gyrate. This motion is unusually well adapted to sifting sand, since a lot of the energy is not wasted in throwing it against the ends of the compartment, as is done in a reciprocating type. Each particle of sand travels around in a circle, so that the small particles reach the sieve in the shortest possible time and the sifting takes place with great rapidity.

The outfit complete weighs only about 90 lb., and



METHOD OF SUSPENDING AND OPERATING GYRATORY FOUNDRY RIDDLE

therefore can be easily moved from place to place as required. The riddle is particularly useful suspended from a trolley running on a cable stretched parallel with the line of moulders in the foundry.

The riddle is operated by a Westinghouse totally-enclosed 1/6-hp. vertical motor, made especially for the Great Western Mfg. Co., of Leavenworth, Kansas, builders of the outfit. As the total power is obtained from the unbalanced effect of the flywheel, the power required to drive the riddle is exceedingly small, and a cord and plug fitting any lamp socket is furnished with the motor so that no special wiring is necessary. The motor has a ball-thrust bearing, and a total of only 3 bearings are used in the drive, all of which are dust-proof.

The sieve is 20 in. in diameter, and with this size the riddle is said to do the work of 10 men sifting sand by hand. In fact, the sifting is done so quickly that it will riddle faster than one man can shovel in the sand. As the sieve does not have to be connected to the motor by connecting rods, etc., it can be easily and quickly removed from the clamping device for dumping.

Steam Ejector Ash Removal System

THIS ash removal system, which can be applied to either hand or stoker-fired boilers, is manufactured and installed by Girtanner-Daviess Engineering & Contracting Co., of St. Louis, Mo.

For straight runs, the pipe is made of a special chill, cast iron, 1 in. thick. Bends, which have a 4-ft. radius,

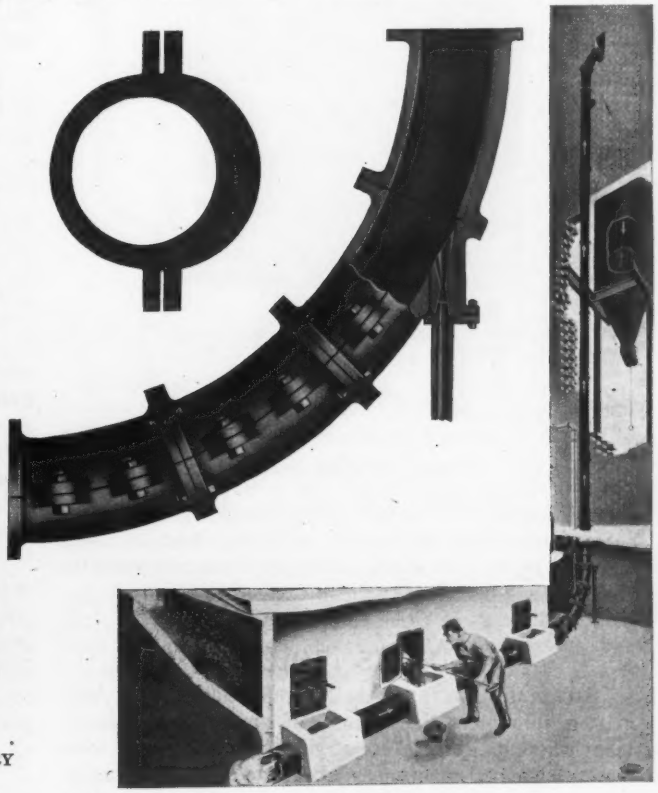


FIG. 1. SHOWING LOCATION OF STEAM NOZZLE IN EJECTOR SECTION AND CROSS SECTION OF ELBOWS

FIG. 2. AN INSTALLATION TO HANDLE ASHES FROM STOKER FIRED PLANT

are constructed of 22.5-deg. elbows, made of a special chill, cast iron, the outer or wear section of the elbow being 2 in. thick, and easily replaced.

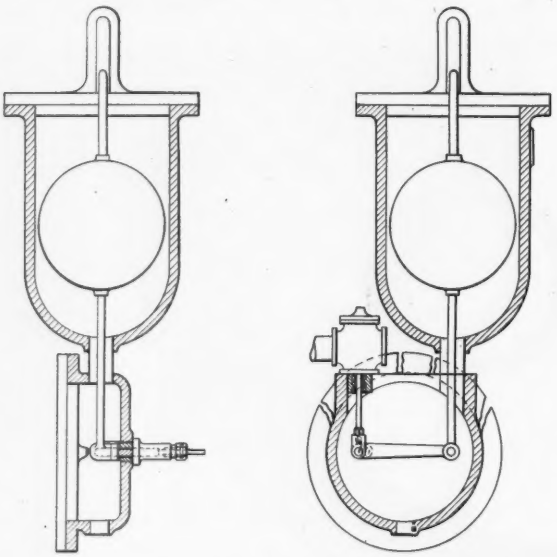
Into one of the parts, called the ejector, is fitted a steam nozzle, especially designed for this work, which at a pressure of 80 lb. or more creates a strong suction.

Ashes are drawn into the openings in the pipe and are carried by the stream of air, induced by the jet, to the ejector, from which point they are forced the remainder of the distance.

The maker's guarantee covers the amount of steam used, the quantity of ashes the system will handle, and the wearing qualities.

Simple Feed Water Regulator

A FLOAT, two levers, and a valve are the only working parts of a feed water regulator made by Jas. H. Fogarty, 126 Liberty St., New York City. The rising or falling of a float, closes or opens, by means of a bell-crank lever, the valve in the feed water line. The action is direct, for as the float drops, its bottom extension bears down on the end of the bell-crank lever, forcing up the stem to the valve, which opens, allowing feed



FOGARTY AUTOMATIC FEED WATER REGULATOR

water to enter the boiler. When sufficient water has entered to restore the proper level, the float in rising will pull up its end of the bell-crank lever and force the feed water valve to seat.

News Notes

SECRETARY BRATE, of the National Gas Engine Association announces the opening of an exchange department where manufacturers of gas engines list their overstock and requirements. An exchange between manufacturers is thus made possible, which works to the advantage of both manufacturers and customers.

THE AMERICAN BLOWER CO. has placed its Chicago office in the Marquette Bldg., in charge of Clark T. Morse, a sales engineer of broad experience. E. L. Hogan has been made western manager of sales engineering for this company.

C. A. CALL, who for the past 5 yr. has been connected with the Advertising Department of the General Electric Co., has recently been appointed Manager of Publicity for the Terry Steam Turbine Co., Hartford, Conn.

RIDGWAY DYNAMO & ENGINE COMPANY announces that on April 1 its Boston office was moved to Room 420 Exchange Building and A. R. Meek was put in charge.

ANNOUNCEMENT is made by the McMaster-Carr Supply Co., that Harry Channon has been elected president, and James A. Delaney, vice-president. This company is located at 174 N. Market St., Chicago.

THE AMERICAN ambassador at Santiago, Chile, reports under date of Feb. 18, that a New York company has secured a contract from the Chilean State Railways for a complete equipment of machinery for the large railway shops that are to replace the various scattered, old repair shops now in existence. The contract amounts to approximately $750,000.

U. S. CIVIL SERVICE COMMISSION announces an examination for heating and ventilating engineer and draftsman, on May 17 and 18, to fill a vacancy at $1200, in the Office of the Supervising Architect, Treasury Department, Washington, D. C., and vacancies as they may occur. Age, 18 yr. or over. Apply for Form 1312, to the U. S. Civil Service Commission, Washington, D. C.

THE SUB-COMMITTEE of the Standards Committee, N. G. E. A., will shortly send out requests to all engine manufacturers for dimensions of clutch spiders, to which friction clutch pulleys are attached. It is expected that by securing all of this information from various manufacturers, for all sizes of engines, it will be possible to find certain dimensions that are nearly common and then decide upon a standard that will permit the clutch manufacturer to make his goods uniform. This will insure prompt deliveries, as well as reduced costs. Besides that, if such a standard is secured, it will permit the use of any clutch upon an engine without changes being required. There is considerable sentiment among both the engine manufacturers and the clutch people for the use of the extended shaft on the engine, using a shaft clutch instead of a spider type. If sentiment is crystallized by the committee in this direction, it is possible that the shaft clutch may be accepted as the preferable type.

Secretary Brate is also calling attention to the fact that the bill of Congressman J. J. Casey, H. R. 11,256, providing for an industrial alcohol commission, offers some solution to the future fuel situation, and is recommending that the trade urge upon Congress the speedy adoption of this bill, and that they write to the Secretary of Agriculture and their congressmen and senators to support this measure.

At the convention to be held at the Sherman Hotel, Chicago, June 27-29, tables will be provided for the free exhibit of accessory lines of all kinds. No charge is made for admission or for exhibit space. The only requirements are for those who desire to show their goods is that they be members; will only exhibit their line at such hours as the convention is not in session; that they make arrangements in advance with the secretary, H. R. Brate, of Lakemont, N. Y., advising him of their intention to exhibit. All articles such as magnetos, spark coils, plugs, small forgings and other parts, roller bearings, etc., may be shown.

FOR STUDENT ENGINEERS, a prize contest is offered by the Diamond Power Specialty Co. of Detroit, Mich. This is open only to seniors and post graduates in engineering schools in the United States and Canada, who are following mechanical engineering courses. Choice of subjects is left to the contestants, but several subjects dealing with mechanical soot blowers are suggested. Full details can be obtained from the Diamond Power Specialty Co. in regard to conditions and prizes. The contest closes May 15.

Books and Catalogs

ELEVATORS, by J. H. Jallings, cloth binding, 217 pages, illustrated; Chicago, 1915. Price, $1.50.

In this book the historical progress, beginning with the types of elevators in use 50 or 60 years ago, is followed by stages of development down to the modern system. Manual labor furnished the power of the early elevator of the sling type, and its use was restricted almost entirely to freight hauling. Use of guide rails and anti-friction roller-bearings, the application of a counterbalance, use of wire ropes or cables, and the application of brakes and safety appliances have been essential factors in the development of the modern elevator.

Design, methods of control, and operation for steam, hydraulic and electric elevators are described and the advantages and economical results of each type is considered. Standard layouts, with the necessary auxiliary equipment are shown by diagrams and half-tone views.

The difficulties that were first encountered as each type was introduced and the methods by which the faults were gradually eliminated, are given considerable attention. The book is based upon 50 years of actual experience by the author in elevator construction work.

THE DIESEL ENGINE IN PRACTICE, by J. E. Megson and H. S. Jones; 136 pages, illustrated; San Francisco, Cal., 1916. Price, $2.

This little volume, which is devoted to a detailed discussion of the practical side of the Diesel engine, is based upon the observations and practical experiences of the authors and should readily lend itself to the needs of those but little familiar with this type of prime mover. The various subjects taken up are the history of the Diesel engine, its basis of operation, experiences with the early types, fuel oil, effect of altitude, operation and care, the life and reliability of this engine, discussion of the most prominent types of modern Diesels and semi-Diesels. Chapter X is devoted to the present-day commercial situation of the Diesel engine, while the following chapter gives much valuable information regarding the application of these engines in marine service. The book is concluded with a brief description of the various makes of Diesels found on exhibition at the Panama-Pacific International Exposition.

BULLETIN NO. 27A, issued recently by the Nordberg Mfg. Co., describes their high compression 2-cycle oil engine. The bulletin is illustrated with a number of photographs and detail section drawings of the engine. Power and scavenging cards are also reproduced. Copies will be sent upon application to the Nordberg Mfg. Co., of Milwaukee, Wis.

AUTOGENOUS WELDING of National Pipe is the title of Bulletin No. 26, recently issued by the National Tube Co., of Pittsburgh, Pa. It describes and illustrates, in an interesting manner, the various kinds of pipe work to which oxy-acetylene welding has been applied. Data is given concerning the costs of cutting, welding, and installation of pipe. This booklet contains a large number of illustrations and is a valuable addition to the list of "National" Bulletins.

HAND AND POWER PUMPS is the title of Catalog No. 25, recently received from the Deming Co. of Salem, Ohio. Various classifications and uses of Deming pumps are explained, and a large number of illustrations are

given. Engineering tables and considerable data relating to hydraulics are added. The catalog contains 356 pages and is cloth bound.

POLE LINE HARDWARE, Catalog No. DS846, just issued by the Westinghouse Electric & Mfg. Co., gives complete listing of accessories used in the pole line construction, together with prices and dimensions.

Type CW slip ring induction motors are illustrated and described in section IP54. This is a new pressed steel motor for constant and variable speed continuous duty service now being built by the Westinghouse Company. This type of motor is built in capacities from ½ to 650 hp., 2 and 3-phase, 25 and 60 cycles, 220, 440, 550 and 2200 v.

Trade Notes

FOR THE THIRD time since starting in business 8 yr. ago, the Hill Pump Valve Co. has found it necessary to increase its facilities for making its products and in the new location, 23rd St. and Archer Ave., Chicago, over 14,000 sq. ft. of floor space is completely equipped with modern machinery. The new plant practically doubles the capacity of the old one and ample provision is made for further expansion.

AT THE PLANT of the Goodyear Tire & Rubber Co., Akron, O., the district managers of the sales organization recently spent a week reviewing the work of the past year and planning for the future. The consensus

of opinion was, that the company is well embarked on the most successful manufacturing and sales year in its history, and that the Goodyear Cord tires are meeting with great favor, and are being supplied on a large number of the best makes of cars as regular equipment.

IN 1866, Clark Merchant, who had distinguished himself in the U. S. Navy, and retired with the rank of Lieutenant-Commander, established business in Philadelphia as Merchant & Co., dealing principally in brass, bronze and copper in all its forms as then manufactured, and trading also in tin plates and other metals that were imported from England or other foreign countries. The business expanded and soon necessitated removal to larger quarters. At this time the heaviest importation of Merchant & Co. was in roofing tins, chiefly of the brand known as "Gilbertson's Old Method."

After the McKinley Tariff went into effect, Merchant & Co. gave up the agency for this tin, and decided to erect a dipping plant in Philadelphia to produce plates in this country of equal or better quality. As a result, the "Merchant's Old Method" brand of roofing tin was placed on the market and found to be of distinctly better quality than the "Gilbertson's Old Method" brand.

Continued growth of the business made it necessary to open branch offices and warehouses at several important points in the United States, and enlarge the line of metal products. The co-partnership of Merchant & Co. also changed to a corporation, under the style of Merchant & Co., Inc., with Clark Merchant as its president. This style continued until the death of Mr. Merchant, after which Powell Evans assumed control of the business, which is now conducted under the name of Merchant & Evans Co. Powell Evans is an engineer of international experience and seeing the possibilities available to manufacturers of gasoline propelled vehicles and parts therefor, added to the already extensive line of metal products handled by Merchant & Evans Co., automobile clutches, alinement-joints, rear axles, jackshaft transmissions, grease cups, metal tire cases, and finally completely erected gasoline motor trucks and tractor trucks.

Mr. Evans is widely known as one of the best posted men in fire prevention and protection affairs in this country, and is chairman of the Fire Prevention Committee of the Chamber of Commerce of U. S., the National Hardware Association, and the Fire Prevention Commission of the City of Philadelphia.

To celebrate its 50th anniversary fittingly, and to keep abreast of the growing demands for the products of this company, a large modern office and warehouse has been built adjoining its works on Washington Ave., between 20th and 21st Sts., in Philadelphia, and the company has now completed removal of its general offices and warehouse to this new location. Rapid motor trucks of its own manufacture are used daily to make free delivery into all parts of the city. This company now has plants in Philadelphia, Wheeling and Chicago, and offices and warehouses in Philadelphia, New York, Baltimore, Cleveland, Chicago and Kansas City, with a large force of traveling representatives. It not only covers the entire United States, but is conducting an import business of increasing volume.

PRACTICAL ENGINEER
Trade-mark, Reg. U. S. Pat. Off.
PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.
SEMI-MONTHLY
Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.
In Canada, subscription price, $1.75 a year.
Foreign Countries, subscription price, $2.50 a year.
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Position Wanted

POSITION WANTED—By man who has made steam engineering a life study; have had several years' experience; at present am student in Complete Steam Engineering course with I. C. S. Would like position as engineer, assistant or oiler, with reasonable salary to start, and where I can advance according to merits. Age 26. Address Practical Engineer, Box 419, Chicago, Ill. 4-15-2

POSITION WANTED—As chief engineer or manager of produce cold storage plant. Am familiar with gas, oil and steam engine driven plants, also with D.C. light and power of 250 volts. Erecting, repairing and operating. Employed, married and sober. Will go anywhere. Address Box 428, Practical Engineer, Chicago, Ill. 4-15-2

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 4-1-3

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 3-15-4

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam, electrical, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American and married. Address Box 437, Practical Engineer, Chicago, Ill. 4-1-3

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 3-15-3

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical land refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 3-15-4

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years' practieal experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont St., Portland, Ore. 4-15-2

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letter. Write W. D. Bellesfield, Rock Valley, Iowa. 4-15-2

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 4-15-2

POSITION WANTED—Inside of power plant by young man with a technical education, but no experience. For particulars write to K. Lufter, Kewaunee, Wis. 3-15-3

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

Wanted

WANTED—Well versed boiler room and combustion men or established engineering agencies to sell mechanical stokers on a liberal commission basis. We manufacture three distinct types to meet all requirements. Natural and forced draft. Address Practical Engineer, Box 438, Chicago, Ill. 4-1-4

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Company, Springfield, Ohio. tf.

For Sale

FOR SALE—Drawings of Internal Combustion Engines: (1) Section Four-Cycle Diesel Engine, (2) Section Two-Cycle Diesel Engine, (3) Section Two-Cycle Crude Petroleum Engine, (4) Section Two-Cycle Crude Oil Engine, (5) Air Starting and Reversing System for Diesel Engines, (6) Tre-Ignition Starting and Reversing System for Oil Engines. For one dollar each, or five dollars for the six, I will send the above to any address in the U. S. With each drawing I enclose full explanation of operation. H. J. Teiper, 1808 S. Logan Square, Philadelphia, Pa.

FOR SALE—Two 1040-hp., horizontal, cross-compound heavy duty, mill type, Buckeye engines, 24x42x36, 120 r.p.m.; each direct connected to 500-kw., 250-v. Westinghouse Type "Q" generators. Excellent condition; good as new. Now in operation. If interested, write for full information and prices. Box 197, Elyria, Ohio. 4-15-4

FOR SALE—3 vertical center crank high speed engines, sizes, one 7x8 in., one 8x8 in., one 9x11 in., connected to generator; 2 horizontal fire tube boilers, 55-hp. each. 1 Marsh deep well steam head, 8x36 in. Write or call Wisconsin State Tuberculosis Sanatorium, Statesan, Waukesha County, Wisconsin. 5-1-1

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F. St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F. St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F. St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

ENGINEERS AND FIREMEN—Send 10c in stamps for a 40-page pamphlet containing a list of questions asked by an examining board of engineers. Stromberg Publishing Co., 2238-A Pope Ave., St. Louis, Mo. E.O.I.-tf.

Miscellaneous

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Sparks From The Advertising Pages

In with a batch of letters delivered to our subscription department the other day, one from Ohio furnishes the motif for this article. It is from a subscriber who has been getting Practical Engineer only a few months but who has learned to appreciate it fully and to read and study it thoroughly. His letter winds up thus, "I enjoy your paper and found in the first issue an article I needed very much. I refer to a self-cleaning strainer advertisement."

It was quite a coincidence that just an hour or two after the receipt of this letter, the manufacturer of this strainer came into our office. He was asked whether he had received an order from the Blank Woolen Mills of Ohio, and replied, "Why, yes; that order came in a month or two ago." So our Ohio friend not only "needed" but actually bought the product.

The point we wish to emphasize is this. Here is a man who wanted just what was advertised but who did not know where to get it, or what is more probable, did not even know that such a device was made.

There are backwoods methods still tolerated in many power plants because of the utter lack of information of what the manufacturers of power plant equipment have to offer.

In many instances, engineers are keeping dirt out of a pipe line by placing an inefficient screen in the line before the unit to be protected. The result is a choked-up pipe line, constant cleaning and impaired service. The engineer above referred to might have gone a long time without this convenient and serviceable little device had he not read carefully the advertising section of Practical Engineer.

We might still be using the walking beam engine had not **the printed page** lead us to know about the genuine worth of the Corliss, Uniflow and high speed four-valve engine.

"Yes, but what of the word-of-mouth advertising," you argue.

Word-of-mouth advertising is too slow a process to attribute to its agency, the early success of any marketable product. Then, too, if word-of-mouth advertising is not supported by word-of-ink advertising, there is always room for suspicion and doubt.

Previous to the printing press, progress was measured in years and even centuries. Now it is measured in days and even hours.

The advertising section of Practical Engineer is the engineer's periscope for locating the equipment he ought to have in his plant. Many an engineer has thumbed the advertising pages of Practical Engineer and had his attention riveted on a particular advertisement that has brought a warm glow to his eyes and the Yule-tide expression, "Just what I need."

In every issue of Practical Engineer there is at least one advertisement that you ought to answer. You should read the advertising section with a view to the improvement of your plant—its service—its economical maintenance—its conditions of operation.

With this in mind the initial expense of any product you buy will never hide the ultimate profit.